24-25 FEBRUARY 2021

3RD INTERNATIONAL FORUM ON
ADVANCES IN RADIATION PHYSICS,
KUALA LUMPUR

iFARP3

2021

ORGANISED BY

IRPS

SUNWAY UNIVERSITY

THE UNIVERSITY OF MELBOURNE

UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

3rd International Forum on Advances in Radiation Physics

IN COLLABORATION WITH

THE UNIVERSITY OF MELBOURNE

PREFACE

PROFESSOR DAVID A. BRADLEY

President, International Radiation Physics Society (IRPS)

Distinguished Professor, Sunway University, Malaysia

Emeritus Professor, University of Surrey, UK

Dear Conferees, welcome to IFARP-3, the 3rd International Forum on Advances in Radiation Physics, co-hosted by Sunway University and the University of Melbourne, with Universiti Putra Malaysia as a collaborating body. IFARP-3 follows on from the Buenos Aires FORUMBA; 4-5 May 2017: phttp://forumba2017.ing.unibo.it/) and the Kuala Lumpur IFARP-2; 3-4 December 2019 (with an early 2021 Special Issue of the journal Radiation Physics and Chemistry (RPC) dedicated to the event). These focused meetings of the International Radiation Physics Society (IRPS) are intended to provide timely updates covering the very latest developments and emerging ideas within the underpinning science and radiation technologies. The 3rd International Forum on Advances in Radiation Physics, 24-25 February 2021 is a focused event of the Centre for Applied Physics and Radiation Technologies at Sunway University and the Department of Physics University of Melbourne, in part also allowing us to celebrate the Memorandum of Understanding recently signed between the two Universities, promoting our working together in areas of mutual interest.

IRPS is a society in its 35th year of existence, brought into being as a result of arrangements first agreed in Penang in 1982 at the 2nd International Symposium on Radiation Physics (ISRP-2); our meetings have since circled the globe, triennial events being held in all of the inhabited continents (ISRP-15 will see the Symposium revisiting Malaysia later this year, to be held at Sunway University, 6-10 December 2021).

We wish over the next two days to celebrate the many achievements of the Society, IFARP-3 focusing on the future while also recognizing the considerable advances made in radiation sciences over the several decades since IRPS made it its purpose to promote the interdisciplinary subject of radiation physics including the fundamentals, application, and implications. We are overwhelmed at the response we have had to this particular meeting, attracting participants from more than 20 countries. We are glad you are able to join us and we look forward to learning and sharing from the many experiences that this Forum provides the platform for. Once again, welcome.

D A Bradley
18 February 2021

PROFESSOR CHRISTOPHER T. CHANTLER

Editor-in-Chief, Radiation Physics and Chemistry

Chair, International IUCr Commission on XAFS; CIT, CCN

Immediate Past President, International Radiation Physics Society

It is with great pleasure that I welcome you all to this meeting, the third International Forum on Advanced Radiation Physics, and the inauguration of the Memorandum of Understanding between the University of Melbourne, Australia and Sunway, Malaysia. Malaysia and Australia have had very collegial and constructive interactions going back well over 20 years, and are a firm basis to work with going forwards. Our science overlaps in many areas and the diversity of presentations can be seen in this booklet. We know that all meetings have been forced to undergo structural changes with COVID-19 and this is [now] purely on-line and zoom-based. We partially decided this to maximise possible scientific interest and interaction and also to minimize registration costs. I think you must agree we achieved at least one of those aims!

We do apologise that we must be strict with timing because of the packed meeting, with more registrants and speakers than any past IFARP. We also apologise for the compressed length of the talks – in many cases we would prefer to listen to more details and more science.

So, let us consider this a work in planning, a progress for the future, and an opportunity still to interact and ask questions in the question times after each talk. I do hope most of all that we learn that we can have much to learn from one another, and to see how to work towards that goal. The International Radiation Physics Society is one possible route to connect more regularly with one another and I commend membership of that to you. I also commend the recordings of this meeting so that if inclined you can chase down specific references and contacts after the meeting. With very best wishes, welcome!

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ORGANISING COMMITTEE

CHAIRPERSONS

Prof. David A. Bradley, Sunway University

Prof. Christopher T. Chantler, University of Melbourne

Prof. Iqbal Saripan, Universiti Putra Malaysia

CO-HOSTS

Prof. Mayeen Uddin Khandaker, Sunway University

Prof. Feng Wang, Swinburne University of Technology, Australia

Dr. Chanh Q. Tran, La Trobe University, Australia

Dr. Ming Tsuey Chew, Sunway University

Dr. Siok Ee Lam, Sunway University

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Dr. Siok Ee Lam, Sunway University

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Nicholas Tran, University of Melbourne

Jonathan Dean, University of Melbourne

INVITED SPEAKERS

Professor Christopher T. Chantler
School of Physics, University of Melbourne, Australia

Professor Guinyun Kim
Department of Physics, Kyungpook National University, Republic of Korea

Professor Sultan Dabagov
INFN Laboratori Nazionali di Frascati, Frascati (RM), Italy

Professor Feng Wang
School of Science, Swinburne University of Technology, Australia

Professor Mohammed Alkhorayef
Department of Radiological Sciences, College of Applied Medical Sciences,
King Saud University, Saudi Arabia

Dr. Chanh Q. Tran
Department of Chemistry and Physics, La Trobe University, Australia

PROGRAMME

Day 1 **24 Feb 21,** **Wednesday**	**Time**	**Speaker/Presenter**	**Remarks/Title of Presentation**
Chairpersons **Prof Bradley** **Prof Chantler**	**SESSION 1** **KL 7:00 – 9:00 am** **Mel 10:00 – 12:00 pm**		**Technical Assistants** **Daniel Sier** **Aisha Rozaida**
Welcome Speech	**KL 7:00 – 7:15 am** **Mel 10:00 – 10:15 am** **CET 12:00 – 12:15 am** **SA 2:00 – 2:15 am**	Prof Bradley & Prof Chantler	Welcome speech from the President of International Radiation Physics Society (IRPS) and Editor-in-Chief of Radiation Physics and Chemistry
Sunway University Vice Chancellor Speech	**KL 7:15 – 7:30 am** **Mel 10:15 – 10:30 am** **CET 12:15 – 12:30 am** **SA 2:15 – 2:30 am**	Prof Graeme Wilkinson	Welcome speech and Solemnize MOU between Sunway University and University of Melbourne
Dean Speech, Sunway University	**KL 7:30 – 7:40 am** **Mel 10:30 – 10:40 am** **CET 12:30 – 12:40 am** **SA 2:30 – 2:40 am**	Prof Serge Demidenko	Welcome speech from the Dean of the School of Engineering and Technology, Sunway University
1. Invited Speaker 1	**KL 7:40 – 8:10 am** **Mel 10:40 – 11:10 am** **CET 12:40 – 1:10 am** **SA 2:40 – 3:10 am**	Prof Chantler	Accuracy and insight possible with advanced methods in absorption and fluorescence XAS
2. Invited Speaker 2	**KL 8:10 – 8:40 am** **Mel 11:10 – 11:40 am** **CET 1:10 – 1:40 am** **SA 3:10 – 3:40 am**	Prof Guinyun Kim	Production of medical and industrial radioisotopes from accelerator-based facilities in Korea
3. Presenter 1	**KL 8:40 am – 8:50 am** **Mel 11:40 – 11:50 am** **CET 1:40 – 1:50 am** **SA 3:40 – 3:50 am**	K. Izdihar	Evaluation of X-ray attenuation properties on the various composition of Polydimethylsiloxane (PDMS) kidney phantom
4. Presenter 2	**KL 8:50 – 9:00 am** **Mel 11:50 am – 12:00 pm** **CET 1:50 – 2:00 am** **SA 3:50 – 4:00 am**	J.W. Dean	Absolute energy measurement of scandium K transitions
Hosts **Prof Khandaker** **Aisha Rozaida**	**SESSION 2** **KL 9:00 – 10:00 am** **Mel 12:00 – 1:00 pm**		**Technical Assistants** **Nicholas Tran** **Aisha Rozaida**
5. Presenter 3	**KL 9:00 – 9:10 am** **Mel 12:00 – 12:10 pm** **CET 2:00 – 2:10 am** **SA 4:00 – 4:10 am**	Madeline T. Van Dongen	Design and synthesis better catalysts for low temperature NO_X reduction
6. Presenter 4	**KL 9:10 – 9:20 am** **Mel 12:10 – 12:20 pm**	Ashwini Udupi	A modified prompt gamma-based neutron dose measuring system

	CET 2:10 – 2:20 am **SA 4:10 – 4:20 am**		
7. Presenter 5	**KL 9:20 – 9:30 am** **Mel 12:20 – 12:30 pm** **CET 2:20 – 2:30 am** **SA 4:20 – 4:30 am**	Truong Nguyen	Application of advanced relativistic calculations in atomic and radiation physics
8. Presenter 6	**KL 9:30 – 9:40 am** **Mel 12:30 – 12:40 pm** **CET 2:30 – 2:40 am** **SA 4:30 – 4:40 am**	Siti Nurasiah Mat Nawi	The influence of heating rate on the response and trapping parameters of a promising graphite-based radiation dosimeter
9. Presenter 7	**KL 9:40 – 9:50 am** **Mel 12:40 – 12:50 pm** **CET 2:40 – 2:50 am** **SA 4:40 – 4:50 am**	R.S.K. Ekanayake	Mass attenuation coefficients and X-ray absorption spectroscopy of zinc using X-ray Extended Range Technique-like experiment over energies from 8.51 keV to 11.59 keV
10. Presenter 8	**KL 9:50 – 10:00 am** **Mel 12:50 – 1:00 pm** **CET 2:50 – 3:00 am** **SA 4:50 – 5:00 am**	Dr Geoffrey P. Cousland	High precision energy calibration of a XERT experiment by powder diffractometry
Break	**KL 10:00 – 10:30 am** **Mel 1:00 – 1:30 pm** **CET 3:00 – 3:30 am** **SA 5:00 – 5:30 am**	**Tea break/lunch**	
Hosts **Dr Ming Tsuey Chew** **Dr Siok Ee Lam**	**SESSION 3** **KL10:30 – 12:50 pm** **Mel 1:30 – 3:50 pm**		**Technical Assistants** **Jonathan Dean** **Aisha Rozaida**
11. Presenter 9	**KL 10:30 – 10:40 am** **Mel 1:30 – 1:40 pm** **CET 3:30 – 3:40 am** **SA 5:30 – 5:40 am**	Daniel Sier	High accuracy determination of photoelectric cross sections, X-ray Absorption Fine Structure and nanostructure analysis of zinc selenide using the X-ray Extended Range Technique
12. Presenter 10	**KL 10:40 – 10:50 am** **Mel 1:40 – 1:50 pm** **CET 3:40 – 3:50 am** **SA 5:40 – 5:50 am**	H.A. Melia	The characteristic radiation of Cu Kβ: diagram lines, shake satellites and the radiative Auger effect
13. Presenter 11	**KL 10:50 – 11:00 am** **Mel 1:50 – 2:00 pm** **CET 3:50 – 4:00 am** **SA 5:50 – 6:00 am**	N.A. Muhammad	Influence of paediatric effective diameter on CT dose metrics and size-specific dose estimates (SSDE) value
14. Presenter 12	**KL 11:00 – 11:10 am** **Mel 2:00 – 2:10 pm** **CET 4:00 – 4:10 am** **SA 6:00 – 6:10 am**	Mardhiyati Mohd Yunus	Evaluation of optimum breast compression, adequate image quality and acceptable radiation dose in

			digital breast tomosynthesis (DBT) using breast phantom
15. Presenter 13	**KL 11:10 – 11:20 am** **Mel 2:10 – 2:20 pm** **CET 4:10 – 4:20 am** **SA 6:10 – 6:20 am**	Dr M.K.A. Karim	Task-based assessment of CT performance in CT pulmonary angiography examination using various optimization protocols
16. Presenter 14	**KL 11:20 – 11:30 am** **Mel 2:20 – 2:30 pm** **CET 4:20 – 4:30 am** **SA 6:20 – 6:30 am**	Zunaide Kayun	Radiation doses from CT brain examinations attributes head sizes in a tertiary hospital in Malaysia
17. Presenter 15	**KL 11:30 – 11:40 am** **Mel 2:30 – 2:40 pm** **CET 4:30 – 4:40 am** **SA 6:30 – 6:40 am**	A/Prof Hamid Osman	Radiation dose measurements for Hysterosalpingraphy in Taif Saudi Arabia
18. Presenter 16	**KL 11:40 – 11:50 am** **Mel 2:40 – 2:50 pm** **CET 4:40 – 4:50 am** **SA 6:40 – 6:50 am**	A/ Prof H. Osman	Exposure level in Computed Tomography and conventional x-ray for pelvis in Saudi Arabia
19. Presenter 17	**KL 11:50 am – 12:00 pm** **Mel 2:50 – 3:00 pm** **CET 4:50 – 5:00 am** **SA 6:50 – 7:00 am**	Ew-Jun Chen	The superior quantitative analysis of xQuant reconstruction algorithm in SPECT/CT
20. Presenter 18	**KL 12:00 – 12:10 pm** **Mel 3:00 – 3:10 pm** **CET 5:00 – 5:10 am** **SA 7:00 – 7:10 am**	Dr Hassan Salah	Evaluation of pediatric patient's radiation dose and cancer risk associated with Computed Tomography paranasal sinuses
21. Presenter 19	**KL 12:10 – 12:20 pm** **Mel 3:10 – 3:20 pm** **CET 5:10 – 5:20 am** **SA 7:10 – 7:20 am**	Prof Abdelmoneim Sulieman	Survey of the current CT effective dose and imaging protocols in Saudi Arabia
22. Invited speaker 3	**KL 12:20 – 12:50 pm** **Mel 3:20 – 3:50 pm** **CET 5:20 – 5:50 am** **SA 7:20 – 7:50 am**	Prof M. Alkhorayef	Investigation of using positronium and its annihilation for hypoxia PET imaging
Break	**KL 12:50 – 1:00 pm** **Mel 3:50 – 4:00 pm** **CET 5:50 – 6:00 am** **SA 7:50 – 8:00 am**	**Tea break**	
<u>Hosts</u> **Prof Khandaker** **Aisha Rozaida**	**SESSION 4** **KL1:00 – 2:50 pm** **Mel 4:00 – 5:50 pm**		**<u>Technical Assistants</u>** **Daniel Sier** **Aisha Rozaida**
23. Presenter 20	**KL 1:00 – 1:10 pm** **Mel 4:00 – 4:10 pm** **CET 6:00 – 6:10 am** **SA 8:00 – 8:10 am**	Dr Meshari Alnaaimi	Organs dosimetry in targeted radionuclide therapy in Kuwait

24. Presenter 21	**KL 1:10 – 1:20 pm** **Mel 4:10 – 4:20 pm** **CET 6:10 – 6:20 am** **SA 8:10 – 8:20 am**	Dr Nissren Tamam	Evaluation of patient's radiation dose and cancer risk associated with mammography study
25. Presenter 22	**KL 1:20 – 1:30 pm** **Mel 4:20 – 4:30 pm** **CET 6:20 – 6:30 am** **SA 8:20 – 8:30 am**	Eltayeb Osman	Radiation exposure and establishment dose reference levels interventional for percutaneous coronary interventions procedures
26. Presenter 23	**KL 1:30 – 1:40 pm** **Mel 4:30 – 4:40 pm** **CET 6:30 – 6:40 am** **SA 8:30 – 8:40 am**	H. H. Harun	Effect of different iterative reconstruction algorithm levels on low contrast detectability in CT brain examination.
27. Presenter 24	**KL 1:40 – 1:50 pm** **Mel 4:40 – 4:50 pm** **CET 6:40 – 6:50 am** **SA 8:40 – 8:50 am**	Prof K. Alzimami	Establishment of diagnostic reference levels for pediatric imaging procedures in the Saudi Arabia
28. Presenter 25	**KL 1:50 – 2:00 pm** **Mel 4:50 – 5:00 pm** **CET 6:50 – 7:00 am** **SA 8:50 – 9:00 am**	Arsalan Khan	Analytical study of radiation shielding plan for hybrid imaging technique (SPECT/CT)
29. Presenter 26	**KL 2:00 – 2:10 pm** **Mel 5:00 – 5:10 pm** **CET 7:00 – 7:10 am** **SA 9:00 – 9:10 am**	Awais Khalid	Assessment of radiation dose around patients in SPECT/CT unit
30. Presenter 27	**KL 2:10 – 2:20 pm** **Mel 5:10 – 5:20 pm** **CET 7:10 – 7:20 am** **SA 9:10 – 9:20 am**	A/Prof Wadah Mohamed Ali	Estimation of kidney and bladder radionuclide activity during bone scan
31. Presenter 28	**KL 2:20 – 2:30 pm** **Mel 5:20 – 5:30 pm** **CET 7:20 – 7:30 am** **SA 9:20 – 9:30 am**	Rasha Jaafar	Vascular lower extremity angiography multi-phase exposure: Assessment of radiogenic risk and dose reduction techniques
32. Presenter 29	**KL 2:30 – 2:40 pm** **Mel 5:30 – 5:40 pm** **CET 7:30 – 7:40 am** **SA 9:30 – 9:40 am**	Recep Kurtulus/ Dr Taner Kavas	A lanthanum-barium-borovanadate glass containing Bi_2O_3 for radiation shielding applications
33. Presenter 30	**KL 2:40 – 2:50 pm** **Mel 5:40 – 5:50 pm** **CET 7:40 – 7:50 am** **SA 9:40 – 9:50 am**	Dr Nuha Al-Harbi	A novel P_2O_5-CaO-Na_2O-$_2$O-PbO glass systems for radiation shielding in dental applications
Hosts **Prof Chantler** **Prof Bradley**	**SESSION 5** **KL2:50 – 4:00 pm** **Mel 5:50 – 7:00 pm**		**Technical Assistants** **Nicholas Tran** **Aisha Rozaida**

34. Presenter 31	**KL 2:50 – 3:00 pm** **Mel 5:50 – 6:00 pm** **CET 7:50 – 8:00 am** **SA 9:50 – 10:00 am**	Tashlykov O. L / Karem A Mahmoud	Fabrication and radiation shielding features of a novel bismuth-doped barium borate glass system
35. Presenter 32	**KL 3:00 – 3:10 pm** **Mel 6:00 – 6:10 pm** **CET 8:00 – 8:10 am** **SA 10:00 – 10:10 am**	Dr Mengge Dong/ Prof Xiangxin Xue	Studies of physical behaviors of some boron containing resources and nuclear radiation rays
36. Presenter 33	**KL 3:10 – 3:20 pm** **Mel 6:10 – 6:20 pm** **CET 8:10 – 8:20 am** **SA 10:10 – 10:20 am**	A/Prof M.I. Sayyed	Radiation shielding and mechanical properties of Bi_2O_3-Na_2O-TiO_2-ZnO-TeO_2 glass system
37. Presenter 34	**KL 3:20 – 3:30 pm** **Mel 6:20 – 6:30 pm** **CET 8:20 – 8:30 am** **SA 10:20 – 10:30 am**	Ashwitha Nancy D'Souza,	Gamma ray shielding and thermoluminescence investigation of bismuth added heavy metal oxide glasses
38. Presenter 35	**KL 3:30 – 3:40 pm** **Mel 6:30 – 6:40 pm** **CET 8:30 – 8:40 am** **SA 10:30 – 10:40 am**	M.S.D. Sarker/ Prof Rubina Rahman	The presence of primordial radionuclides in powdered milk and estimation of the concomitant ingestion dose
39. Presenter 36	**KL 3:40 – 3:50 pm** **Mel 6:40 – 6:50 pm** **CET 8:40 – 8:50 am** **SA 10:40 – 10:50 am**	Noor Zati Hani Abu Hanifah	Radioactive material in the cosmetic and healthcare products: A review on the regulatory controls
Closing Remarks	**KL 3:50 – 4:00 pm** **Mel 6:50 – 7:00 pm** **CET 8:50 – 9:00 am** **SA 10:50 – 11:00 am**	**Prof Chantler & Prof Bradley**	

Day 2 25 Feb 21, Thursday	**Time**	**Speaker/Presenter**	**Remarks/Title of Presentation**
Hosts Prof Bradley Prof Chantler	**SESSION 1 KL 7:00 – 9:25 am Mel 10:00 – 12:25 pm**		**Technical Assistants Jonathan Dean Aisha Rozaida**
Opening Remarks	**KL 7:00 – 7:15 am Mel 10:00 – 10:15 am CET 12:00 – 12:15 am SA 2:00 – 2:15 am**	Prof Bradley and Prof Chantler	President of International Radiation Physics Society (IRPS) and Editor-in-Chief of Radiation Physics and Chemistry
1. Invited Speaker 1	**KL 7:15 – 7:45 am Mel 10:15 – 10:45 am CET 12:15 – 12:45 am SA 2:15 – 2:45 am**	Prof Sultan Dabagov	X-ray spectroscopy and microscopy studies at XLabFrascati
2. Invited Speaker 2	**KL 7:45 – 8:15 am Mel 10:45 – 11:15 am CET 12:45 – 1:15 am SA 2:45 – 3:15 am**	Prof Feng Wang	Structure and dynamics of ferrocene and decamethylferrocene
3. Invited Speaker 3	**KL 8:15 – 8:45 am Mel 11:15 – 11:45 am CET 1:15 – 1:45 am SA 3:15 – 3:45 am**	Dr Chanh Q. Tran	Complex atomic fine structures in the phase domain: exciting opportunities and challenges
4. Presenter 1	**KL 8:45 – 8:55 am Mel 11:45 – 11:55 am CET 1:45 – 1:55 am SA 3:45 – 3:55 am**	Prof H.A. Abdul-Rashid	Recent developments in optical fiber radiation dosimetry
5. Presenter 2	**KL 8:55 – 9:05 am Mel 11:55 – 12:05 pm CET 1:55 – 2:05 am SA 3:55 – 4:05 am**	A. Basaif	Ge doped fiber for time resolved radiation dosimetry
6. Presenter 3	**KL 9:05 – 9:15 am Mel 12:05 – 12:15 pm CET 2:05 – 2:15 am SA 4:05 – 4:15 am**	A. Oresegun	Radioluminescence of silica optical fiber for industrial radiation dosimetry
Dean Speech, University of Melbourne	**KL 9:15 – 9:25 am Mel 12:15 – 12:25 pm CET 2:15 – 2:25 am SA 4:15 – 4:25 am**	**Professor Moira O'Bryan**	Welcome speech from the Dean of the Faculty of Science, University of Melbourne
Hosts Dr Chanh Tran Aisha Rozaida	**SESSION 2 KL 9:25 – 10:05 am Mel 12:25 – 1:05 pm**		**Technical Assistants Daniel Sier Aisha Rozaida**
7. Presenter 4	**KL 9:25 – 9:35 am Mel 12:25 – 12:35 pm CET 2:25 – 2:35 am**	N.F. Ismail	Assessment of radon in domestic water resources in South West Coastal of Peninsular Malaysia

	SA 4:25 – 4:35 am		
8. Presenter 5	**KL 9:35 – 9:45 am** **Mel 12:35 – 12:45 pm** **CET 2:35 – 2:45 am** **SA 4:35 – 4:45 am**	S.S. Ismail	Neutron irradiation effect on structural and optical properties of gadolinium-doped silica glass
9. Presenter 6	**KL 9:45 – 9:55 am** **Mel 12:45 – 12:55 pm** **CET 2:45 – 2:55 am** **SA 4:45 – 4:55 am**	Edwin Humphrey Uguru	Impact of gadolinium weight percent and the number of its fuel rods on the neutronic and safety parameters in a fuel matrix
10. Presenter 7	**KL 9:55 – 10:05 am** **Mel 12:55 – 1:05 pm** **CET 2:55 – 3:05 am** **SA 4:55 – 5:05 am**	Truong-Son Truong	Validation of ROOT and R Packages in performing for gamma-ray spectrum analysis
Break	**KL 10:05 – 10:35 am** **Mel 1:05 – 1:35 pm** **CET 3:05 – 3:35 am** **SA 5:05 – 5:35 am**	**Tea break/lunch**	
<u>Hosts</u> **Prof Feng Wang** **Aisha Rozaida**	**SESSION 3** **KL 10:35 – 11:25 am** **Mel 1:35 – 2:25 pm**		**<u>Technical Assistants</u>** **Nicholas Tran** **Aisha Rozaida**
11. Presenter 8	**KL 10:35 – 10:45 am** **Mel 1:35 – 1:45 pm** **CET 3:35 – 3:45 am** **SA 5:35 – 5:45 am**	Prof P.J. Jojo	HBRA in the coastal Kerala in India and concerns on certain congenital malformations
12. Presenter 9	**KL 10:45 – 10:55 am** **Mel 1:45 – 1:55 pm** **CET 3:45 – 3:55 am** **SA 5:45 – 5:55 am**	S.R. Soniya	Correlation between Radium and Radon Exhalation from building materials
13. Presenter 10	**KL 10:55 – 11:05 am** **Mel 1:55 – 2:05 pm** **CET 3:55 – 4:05 am** **SA 5:55 – 6:05 am**	Dhanya Balakrishnan	Inhalation dose in the indoor environment of floor Industrial Area, Kerala
14. Presenter 11	**KL 11:05 – 11:15 am** **Mel 2:05 – 2:15 pm** **CET 4:05 – 4:15 am** **SA 6:05 – 6:15 am**	Arunima S.	A study on leaching of primordial radionuclides to water bodies
15. Presenter 12	**KL 11:15 – 11:25 am** **Mel 2:15 – 2:25 pm** **CET 4:15 – 4:25 am** **SA 6:15 – 6:25 am**	A/Prof Pervaiz Ahmad	Hexagonal boron nitride nanoparticles: A potential material for solid-state neutron detector
<u>Hosts</u> **Prof Bradley** **Prof Chantler**	**SESSION 4** **KL 11:25 – 1:35 pm** **Mel 2:25 – 4:35 pm**		**<u>Technical Assistants</u>** **Jonathan Dean** **Aisha Rozaida**

16. Presenter 13	**KL 11:25 – 11:35 am** **Mel 2:25 – 2:35 pm** **CET 4:25 – 4:35 am** **SA 6:25 – 6:35 am**	Dr Sy Minh Tuan Hoang	Obtaining a precise SOBP profile in the thyroid cancer therapy using SDTrimDP code
17. Presenter 14	**KL 11:35 – 11:45 am** **Mel 2:35 – 2:45 pm** **CET 4:35 – 4:45 am** **SA 6:35 – 6:45 am**	Dr Amir Entezam	Investigation of scattered dose in a mouse phantom for pre-clinical dosimetry studies
18. Presenter 15	**KL 11:45 – 11:55 am** **Mel 2:45 – 2:55 pm** **CET 4:45 – 4:55 am** **SA 6:45 – 6:55 am**	Paul Di Pasquale	Absolute determination of complex fine structure
19. Presenter 16	**KL 11:55 am – 12:05 pm** **Mel 2:55 – 3:05 pm** **CET 4:55 – 5:05 am** **SA 6:55 – 7:05 am**	Nicholas Tran	Resolution of ferrocene and deuterated ferrocene conformations using dynamic vibrational IR spectroscopy
20. Presenter 17	**KL 12:05 – 12:15 pm** **Mel 3:05 – 3:15 pm** **CET 5:05 – 5:15 am** **SA 7:05 – 7:15 am**	Tony Kirk	Critical measurement of the phase fine structures across the copper K-edge
21. Presenter 18	**KL 12:15 – 12:25 pm** **Mel 3:15 – 3:25 pm** **CET 5:15 – 5:25 am** **SA 7:15 – 7:25 am**	Alexander Hill	Intramolecular hydrogen bonding impact on O1s XPS of salicylic acid stereoisomers and their digital structures
22. Presenter 19	**KL 12:25 – 12:35 pm** **Mel 3:25 – 3:35 pm** **CET 5:25 – 5:35 am** **SA 7:25 – 7:35 am**	Minh H. Dao	Fourier transform holography with extended reference
23. Presenter 20	**KL 12:35 – 12:45 pm** **Mel 3:35 – 3:45 pm** **CET 5:35 – 5:45 am** **SA 7:35 – 7:45 am**	Sallam Alagawani,	Halogen impact on the UV-vis spectra of 4-Anilinoquinazoline tyrosine kinases inhibitors (TKIs)
24. Presenter 21	**KL 12:45 – 12:55 pm** **Mel 3:45 – 3:55 pm** **CET 5:45 – 5:55 am** **SA 7:45 – 7:55 am**	Dr. Yehia Manawi	Assessment of natural radioactivity and radiological risks from groundwater and vegetation samples collected from farms in Qatar
25. Presenter 22	**KL 12:55 – 1:05 pm** **Mel 3:55 – 4:05 pm** **CET 5:55 – 6:05 am** **SA 7:55 – 8:05 am**	M.Y. Hanfi	Natural radioactivity in the prospecting tunnel in Egypt: Dose rate and risk assessment
26. Presenter 23	**KL 1:05 – 1:15 pm** **Mel 4:05 – 4:15 pm** **CET 6:05 – 6:15 am** **SA 8:05 – 8:15 am**	Dr N. Maltar-Strmečki	Salty crackers as dosimeters in radiological and nuclear emergencies: improving sample preparation

27. Presenter 24	**KL 1:15 – 1:25 pm** **Mel 4:15 – 4:25 pm** **CET 6:15 – 6:25 am** **SA 8:15 – 8:25 am**	Dr Ines Krajcar Bronić/Dr Damir Borković	Solar activity cycles recorded in long-term data on tritium activity concentration in precipitation at Zagreb, Croatia
Closing Remarks	**KL 1:25 – 1:35 pm** **Mel 4:25 – 4:35 pm** **CET 6:25 – 6:35 am** **SA 8:25 – 8:35 am**	**Prof Bradley & Prof Chantler**	

KL = Kuala Lumpur; Mel = Melbourne; CET = Central European Time; SA = Saudi Arabia

ABSTRACTS

Invited Speakers

Accuracy and insight possible with advanced methods in absorption and fluorescence XAS

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Keywords: Synchrotron Science, X-ray Absorption Spectroscopy, Fluorescence

Abstract

We have achieved accuracies in attenuation coefficient and X-ray absorption fine structure of below 0.2%. This requires careful sample characterisation, monochromator and detector characterisation and additional experimental components to address systematics. Over the past two years we have begun implementation at the Australian Synchrotron with excellent precision using XERT and Hybrid techniques in transmission and fluorescence geometries. Insight includes high accuracy of derived dynamical bond length, thermal parameters, consistency and inconsistency of energy offsets revealed from the data, and structural determination of nearby shells approaching an ab initio manner with XAS. It has allowed exploration of atomic form factors[1], XAFS dynamical bonding[2], electron inelastic mean free paths[3] and nanoroughness[4] appropriate for circuit quality control, with technological offshoots into detector and synchrotron diagnostics. The accurate characterization of fluorescence spectroscopy and of organometallic complexes is developing[5]. This has allowed investigation of dynamic behaviour including the investigation of the reaction coordinate[6], thermal isotropy, and Debye behaviour. It has permitted the first X-ray measurements of electron inelastic mean free path[7]. This paper will explore the requirements for and applicability of higher accuracy in XAFS, the advantage of theory simultaneously fitting XANES and XAFS[8], opportunities for advanced dynamics and Debye studies, and potential for resolving challenges in catalytic and active centres. The quality of XAFS data and the intrinsic information content can be outstanding, and its ability to determine bonding and dynamical modes can be unsurpassed. The talk will look towards opportunities not yet realised in advanced analysis and disorder measurement.

1. de Jonge, MD et al. *Phys. Rev.* A75 032702 (2007)
2. Glover, JL et al. *J. Phys. B* 43 085001 (2010)
3. Chantler, CT, Bourke, JD, *J Phys Chem Letts* 1 2422 (2010); Bourke, JD, Chantler, CT, *Phys. Rev. Lett.* 104, 206601 (2010)
4. Glover, JL et al. *Phys. Lett.* A373 1177 (2009)
5. Chantler, CT et al. *J Synch. Rad.*19 145 (2012)
6. Best, SP et al. *Chemistry - A European Journal*, 22 18019-18026 (2016)
7. Chantler, CT, Bourke, JD. *J Phys Chem* A118 909-914 (2014)
8. Bourke, JD et al. *J Synch Rad* 23 551-559 (2016)

Production of medical and industrial radioisotopes from accelerator-based facilities in Korea

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Abstract

We measured production cross-sections of medical and industrial radioisotopes based on proton, deuteron and alpha particle- as well as neutron-induced reactions by using the stacked-foil activation technique at the MC-50 cyclotron facility in the Korean Institute of Radiological and Medical Science (KIRAMS). The quasi-mono energetic neutrons were produced from the ^{9}Be(p,xn) reaction with the proton energy of 25-45 MeV from the MC-50 Cyclotron facility in KIRAMS.

We also measured production cross-sections of medical and industrial radioisotopes based on high-energy bremsstrahlung generated using the 100-MeV electron linac of the Pohang Accelerator Laboratory (PAL). For the measurement of activity of radioisotope, off-line □-ray spectrometric technique was used in all the experiments.

X-ray Spectroscopy and Microscopy Studies at XLabFrascati

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Abstract

Recent advances in X-ray techniques, including also X-ray optics, have paved the way to obtain challenging results in several research fields at conventional laboratory sites. This is particularly true for X-ray fluorescence (XRF) where the combination of conventional X-ray sources with polycapillary optics has permitted delivering high flux of a shaped beam on a sample under investigation. However, advanced polycapillary technology becomes also very powerful X-ray instrument for high resolution imaging and micro-tomography of low contrast objects.

XLab Frascati is a laboratory at LNF INFN, in one part of its activity, X-ray based experimental, opened to external users for different analyses ranging from the structural studies through X-ray diffraction to the elemental mapping by means of μX-ray fluorescence, allowing also both the colour tomography and X-ray imaging investigations. Based on advanced polycapillary optics, which is under our own production at the dedicated technological pool X-Channel, we have recently designed and, after the commissioning, established two experimental layouts, i.e. XENA - the X-ray Experimental station for Non-destructive Analysis and RXR - the Rainbow X-Ray station for advanced combined analysis. The know-how on the polycapillary optics enable us improving the performances of our setups by adopting the best fitting X-ray optics according to the experimental requirements. The main advantage of RXR is that the detection system includes two spectrometers working in high, up to 25 keV (arranged in the polycapillary confocal geometry) and low, down to 0.8 keV, X-ray energies, respectively, permitting both 2D μXRF scan and 3D μXRF elemental mapping (colour tomography) due to the confocal geometry with a 3-axis fine-motion system.

In this report we present our recent results, in particular, the 2D/3D μXRF analyses of chemical composition of tree rings with respect the influence of the environmental context, of various archaeological fragments to make a 3D reconstruction of elemental composition and assess the presence of various damages as well as X-ray imaging and μCT/dynamic CT to characterize LiF detectors, studying concrete static organic and fast dynamic samples.

Structure and dynamics of ferrocene and decamethylferrocene

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Abstract

As the most well-known organometallic complex, the robustness of ferrocene (Fc) allows its rings to be derivatized using reactions common in organic chemistry, affording easy access to many organometallic compounds. The physico-chemical properties of Fc and its derivatives lend themselves to application in a wide range of fields, including catalysis, materials science and sensing as well as medicinal chemistry. [1] However, very low energy barrier and dynamics of Fc conformers have been the target of debate since its discovery until recently. [2] [3] [4] [5] [6]. It is important to understand the structure and dynamics of Fc as the ferrocenyl group take either eclipsed or stagger form, depending on the ligands in the derivatives. In the talk, I will review the development of Fc study, in collaboration with both theory and experiment, in the past decade. I will concentrate on the conformation and dynamic study of Fc and its methylated derivative decamethylferrocene (*Fc), properties they share and they don't share. I will also provide theoretical evidences that the roles of the core electrons (1s22s22p63s23p6) of the centre Fe atom between *Fc and Fc.

[1] Patra, et al "The medicinal chemistry of ferrocene," Nature Reviews Chemistry, vol. 1, p. 0066, 2017.

[2] Mohammadi, et al "Differentiation of ferrocene D5d and D5h conformers using IR spectroscopy.," Journal of Organometallic Chemistry, pp. 51-59, 2012.

[3] Bourke, et al "Conformation Analysis of Ferrocene and Decamethylferrocene via Full-Potential Modeling of XANES and XAFS Spectra.," The Journal of Physical Chemistry Letters, pp. 2729-2796, 2016.

[4] S. P. Best, et al "Reinterpretation of Dynamic Vibrational Spectroscopy to Determine the Molecular Structure and Dynamics of Ferrocene.," Chemistry - A European Journal, pp. 18019-18026, 2106.

[5] Trevorah, et al "Resolution of ferrocene and deuterated ferrocene conformations using dynamic vibrational spectroscopy: Experiment and theory," Inorganica Chimica Acta, vol. 506, p. 119491, 2020.

[6] Wang et al "Molecular dynamics study of ferrocene topology under various temperatures," International Journal of Quantum Chemistry, p. e26398, 2020.

Investigation of using positronium and its annihilation for hypoxia PET imaging

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Keywords: Tumor hypoxia, 3γ annihilation, Tissue oxygenation, Positronium

Abstract

Determining the oxygenation status in tumor hypoxia is a challenge in cancer imaging. Many ongoing clinical trials are using conventional positron emission tomography (PET) scans and PET agents as cellular markers to detect tumor hypoxia based on the physics of 2γ annihilation. However, few studies in the literature explored the positronium and its annihilation process as an oxygen-sensitive PET marker. The effective yield of 3γ annihilation depends on the rates of formation and quenching. The formation of positronium is sensitive to physical parameters and behaves as an active chemical particle. A hypoxic cell is one that resides in a microenvironment with an inadequate oxygen supply. Oxygen is known to be a strong positronium quencher where 2γ annihilation replaces the 3γ process. Therefore, hypoxic cells can be characterized by higher 3γ rates than those of well-oxygenated cells. This work aims to develop and optimize techniques for measuring 3γ yield using peak-to-peak and peak-to-valley methods and 3γ coincidence events in different environments of variable oxygen concentrations. This will address the possibility of exploiting 3γ annihilation in PET imaging to measure relative tissue oxygenation in oncology. However, it is essential to develop more practical methods of preparing biological samples of different oxygen concentrations for clinical use. Therefore, the proposed research is a step toward applying the novel modality of 3γ PET, which, in conjunction with conventional 2γ PET, could serve as a non-invasive oxygen-sensitive marker.

Complex atomic fine structures in the phase domain: exciting opportunities and challenges

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Abstract

X-ray Absorption Spectroscopy has been one of the most powerful tools for probing atomic and molecular structures of materials. However, the measured fine structures in the absorption domain do not have adequate dimensionalities to extract three-dimensional structural information of the material of interest. A technique that allows accurate measurements of atomic-fine structures in the phase domain will open exciting opportunities in a wide range of fundamental and applied research. In this presentation, we will review existing phase measurement techniques and outline a simple, accurate phase spectroscopy technique for measuring atomic fine structures in an absolute scale.

ABSTRACTS

Presenters

Evaluation of X-ray attenuation properties on the various composition of Polydimethylsiloxane (PDMS) kidney phantom

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Keywords: PDMS, PhyX-Zetra, Effective atomic number, Kidney phantom

Abstract

A multimodal phantom has been successfully innovated with the use of polydimethylsiloxane (PDMS) and hydrophilic silicone (HS). This study aims to study the radiation attenuation properties (μ/ρ) of PDMS with water and hydrogen silicone effect to radiation attenuation. The modification of PDMS were done based on the total weight 20 g which the samples were added 20% hydrogen silicone. Apart from that water also been modified for about 5 samples with the water and HS increase by 4g for total weight 20g respectively. Then radiation attenuation property was measured by using PhyX-Zetra for PDMS phantoms with chemical formula of C_2H_6OSi, Hydrogen Silicone $C_7H_{22}O_2Si_3$ and water H_2O. The values of Zeff, mean attenuation coefficient, linear attenuation coefficient, and CT number for PDMS S0 is highest among the other samples reported. This is due pure PDMS without water and hydrogen silicone, in addition the PDMS S1 also without water but has 20% hydrogen silicone is higher than PDMS S2 that has 20% water and without hydrogen silicone. Therefore, it is proved that water show significant role in altering the radiation attenuation properties for photon energy. The effective atomic number for soft tissue and PDMS is differ, but their atomic number differs due to higher element such as Si. The values of Zeff for PDMS S0 and S1 are higher than normal kidney for the energy range 0.001–0.1 MeV.

Resolution of ferrocene and deuterated ferrocene conformations using dynamic vibrational IR spectroscopy

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Abstract

The signature of molecular vibrations and distortions in dynamic molecules gives a complex fingerprint which is insightful and can substantiate chemical hypotheses regarding molecular and conformer stability. Using high-accuracy experimental data of ferrocene (Fc) and deuterated ferrocene (dFc, Fc−d10) at temperatures from 7 K through to 388 K, we obtain complex spectral profiles which require an advanced reaction coordinate model to explain. We obtain compelling evidence that the single conformer model (staggered D_{5d} or eclipsed D_{5h}) used to interpret and explain many experimental results on ferrocene is invalid. We also present compelling evidence that mixed conformer models are invalid, where ferrocene is represented by an effective dihedral angle between the cyclopentadienyl (Cp) rings; or by a mixture of Boltzmann populations of the two conformers. We find no evidence for single or mixed conformer models despite covering almost all conclusions from past literature for gas, solution or solid phase Fc. A new principle based on the reaction coordinate is introduced using advanced spectroscopy and modelling for hypothesis testing, to articulate the nature of the potential surface, the reaction coordinate, and subtle conformational changes in dilute systems. Our experimental analysis shows that the lowest energy conformer is D_{5h} for both Fc and dFc. We obtain agreement of the model with the complex spectral evolution of profiles. These new techniques are sensitive discriminants of alternate models and chemical systems, which argues for wider application to other complex or impenetrable problems across fields arising for numerous other solutions, frozen or at room temperature.

Absolute energy measurement of scandium K transitions

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Abstract

The absolute energy of scandium (Z=21) Kα and Kβ have not been measured in over 50 years. The uncertainty was of order 100ppm. The lack of a measurement is due to the difficulty of soft X-ray crystallography. Similarly, calcium (Z=20) has not been measured in over 50 years. We report Sc $K\alpha_1^0$, $K\alpha_2^0$, $K\beta_1^0$ energies of 4090.773eV, 4086.253eV, and 4461.103eV with uncertainties 2.5ppm, 4.4ppm, and 2.0ppm. Showing great progress in the area of soft X-ray measurement. Theoretical expectations are that the intensity ratio $I(K\alpha_2):I(K\alpha_1)$ is 0.5. However, this increases with Z, known as the anomalous Z-dependence. Further anomalies are origin of satellite components which are seen in the asymmetries of both the Kα and Kβ spectra. This experiment has consequences in advanced atomic physics, by testing the origin of satellite lines and theoretical calculations of energy. Furthermore, implications for further soft X-ray physics research are shown outlining the possibility for crystallography to obtain high accuracy energy measurements of X-rays down to the 4keV range. A 20 keV electron gun bombards samples of elements Z=21 to Z=25 creating K series fluorescence. A Ge (220) crystal Bragg diffracts a beamline towards the multi wire proportional counter (MWPC) with backgammon geometry detector. The angle was measured by gravity referenced clinometers requiring precise calibration.

The influence of heating rate on the response and trapping parameters of a promising graphite-based radiation dosimeter

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Keywords: Kinetic parameters, Activation energy, Variable heating rate method, Raman and Photoluminescence spectroscopy, X-ray diffraction

Abstract

Characterization has been undertaken of the thermoluminescence (TL) properties of 0.3 mm polymer pencil lead graphite (PPLG) with maximum temperature at 300 $^{\circ}$C and recorded at different heating rates from 2 to 15 $^{\circ}$C s^{-1}, use being made of gamma irradiation doses ranging from 0.5 Gy up to 20 Gy. The PPLGs were observed to provide TL response linear as a function of radiation dose and show the higher sensitivity at the lowest dose. The principal trap parameters of PPLG were estimated by the variable heating rate method. The trap parameters include the order of kinetics, the activation energy, the frequency factor, and the initial concentration of trapped electrons. Approximate relations to estimate the temperature lag between the heating element and the dosimeter across the sample that are known to exists during a thermoluminescence measurement also are determined in this study. The lifetime of the TL glow peak was also calculated, the stability of TL signal being examined at room and peak temperatures. Structural interaction alterations of the irradiated PPLGs were observed via Raman and Photoluminescence (PL) spectroscopy and X-ray diffraction (XRD), providing information on the physical parameters of the defects participating in luminescence process. The reported results demonstrate that 0.3 mm polymer pencil lead graphite has a promising potential as new generation of a radiation dosimeters in medical application.

Mass attenuation coefficients and X-ray absorption spectroscopy of zinc using X-ray Extended Range Technique-like experiment over energies from 8.51 keV to 11.59 keV

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Abstract

We achieved high accurate X-ray absorption measurements of zinc using X-ray Extended Range Technique (XERT)-like experiment across energies from 8.51 keV to 11.59 keV including the zinc K-absorption at the Australian Synchrotron. The XERT technique can identify and quantify experimental systematic errors due to dark current nonlinearities, blank measurements, thickness errors, scattering, harmonics, roughness of the sample and energy over an extended range of experimental parameter space. The mass attenuation coefficients of zinc are determined to an accuracy ranging from 0.024% to 0.032%. Dark current correction was achieved up to 57% for thick sample foils and it is also significant for thin samples. Blank measurements normalization contributes up to 500% for thin foils and 90% for thick foils. Full-foil mapping method calibrate the thicknesses of foil and hence the absolute values of mass attenuation coefficients were determined. The energies were calibrated using standard reference foils. The fluorescence scattering was significant and was characterized. Harmonics and roughness were explored. These highly precise measurements were used to investigate the discrepancies between the theory and experiment. High accurate X-ray absorption fine structure data can be used to explore the structure and thermo dynamics of zinc.

High precision energy calibration of a XERT experiment by powder diffractometry

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Abstract

Careful measurement of systematics during X-ray Extended Range Technique (XERT) experiments provide some of the most accurate [μ/ρ] to date, with results 1 to 2 orders of magnitude better than non-XERT (for the same materials) now commonplace. XERT is useful for standardising measurements for synchrotrons anywhere worldwide, delivering the ability to compare what had until now been fairly disparate results for similar materials. During an XERT experiment the monochromator is rotated to position, providing a near-monochromatic beam of photons. Each photon wavelength has a particular energy (E) and all contributions to [μ/ρ] (systematics) are recorded for this single setting before the monochromator is again rotated and measurements repeated. The monochromator supplies photon energy increments ($\Delta E \approx 1$ keV) over a range here (typically) $6 < E < 21$ keV. The photon energies provided by monochromator drive-electronics are imprecise and external processes are required to obtain higher-precision. Justifiably, energy measurements are run concurrent with those for experiment systematics. I use datasets from Zinc, Zinc Selenide and Selenide experiments obtained at the Australian National Beamline Facility, The Photon Factory, Tsukuba, Japan (2006) to describe energy calibration using BigDiff, which was then the powder diffractometer at the ANBF. BigDiff construction includes a 57 cm diameter drum in Debye-Scherrer geometry, 8 Fuji image plates inside the drum circumference (angular range $\approx 330^{o}$), and calibrated using radioactive fiducials. I describe the creation of an energy calibration catalogue using this dataset, peak fitting (IDL) routines for two NIST-standard powders (Si-640a and LaB6-660a) and lastly, produce precise energy estimates.

High accuracy determination of photoelectric cross sections, X-ray Absorption Fine Structure and nanostructure analysis of zinc selenide using the X-ray Extended Range Technique

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Abstract

Measurements of mass attenuation coefficients and X-ray absorption fine structure (XAFS) of zinc selenide (ZnSe) are reported to accuracies typically better than 0.13%. The high accuracy of the results presented here is due to our successful implementation of the X-ray Extended Range Technique (XERT), a relatively new methodology, which can be implemented on most synchrotron X-ray beamlines. 561 attenuation coefficients were recorded in the energy range of 6.8 keV to 15 keV with measurements concentrated at the zinc and selenium pre-edge, near edge and fine structure absorption edge regions. This accuracy yielded detailed nanostructural analysis of room temperature ZnSe with full uncertainty propagation. Bond lengths, accurate to 0.003 Å to 0.009 Å, or 0.1% to 0.3%, are plausible and physical. Small variation from a crystalline structure suggests local dynamic motion beyond that of a standard crystal lattice, noting that XAFS is sensitive to dynamic correlated motion. The results obtained in this work are the most accurate to date with comparisons to theoretically determined values of the attenuation showing discrepancies from literature theory of up to 4%, motivating further investigation into the origin of such discrepancies.

The characteristic radiation of Cu Kβ: diagram lines, shake satellites and the radiative Auger effect

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Abstract

Characteristic atomic spectra have been used for decades in a range of scientific applications. Knowledge of the precise shape of X-ray spectra is fundamental in the calibration of energy scales worldwide. Asymmetries in the line shape have long been explained by the presence of spectator vacancies creating shake satellites. The radiative Auger effect give rise to separate satellite lines - radiative Auger satellites (RAS). The contribution of the radiative Auger effect is shown to significantly change long standing literature characterisations of the Cu Kβ spectrum. The University of Melbourne backgammon type MWPC was used to record the X-ray spectrum of Cu. Characteristic X-ray radiation was generated by a MAC Science SRA M18XH1 water cooled rotating anode source and diffracted onto the detector face via a monolithic Si double-crystal monochromator. Two characterisations of the Cu K$\beta_{1,3}$ spectrum are presented. A five Lorentzian fit - in good agreement with literature standards, - and an improved characterisation including radiative Auger emission. This is a step in the renewed efforts to resolve inconsistencies between theory and common experimental geometries. The importance of including RAS is demonstrated as well as an investigation into how to model RAS in X-ray spectra. The contribution of the $KM_{2,3}M_{4,5}$ and $KM_{2,3}N_1$ radiative Auger satellites to the K$\beta_{1,3}$ spectrum is shown to be 1.96%.

Application of advanced relativistic calculations in atomic and radiation physics

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Abstract

Theoretical atomic structural studies of multi-electron atoms have come a long way since the discipline was first seriously examined in the 1930s. Over the many decades since, it has proven to have wide-ranging applications across many different fields beyond physics. Although advances in this area of study have allowed us to push towards boundaries that were previously thought impossible, they have also invited further complex questions of relativistic quantum mechanics and challenged our understanding of the fundamental building blocks of the natural world. The presentation will discuss the multiconfiguration Dirac-Hartree-Fock method for atomic structural calculations. This is one of the most advanced techniques in the world which utilises fully relativistic wavefunctions to obtain transition energies, probabilities, and profiles with an exceptional level of accuracy. However, to be able to obtain high-accuracy results using this method is no simple task. The robustness and challenges of this theory will be demonstrated through examples of recent work.

Critical measurement of the phase fine structures across the copper K-edge

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Abstract

Current applications of X-ray Absorption Fine Structure to low absorbing samples such as ultra-thin films in semiconductor and nano-devices have been limited. This is expected to not be the case for the phase component of the fine structure as it is generally orders of magnitude larger than the absorption component in the x-ray regime. We will present details of an experimental measurement to retrieve the phase and absorption components of a copper thin film simultaneously at the XFM beamline of the Australian Synchrotron by applying the Fourier Transform Holography technique across the copper K-edge. The results provide critical experimental benchmark for further theoretical development and has potential to delve into the phase equivalent of the XAFS technique.

Absolute determination of complex fine structure

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Abstract

X-Ray Absorption Fine Structure is a widely used method for investigating properties of molecular structures. Absorption-based measurements have been extensively investigated, leading to the development of X-ray Extended Range Technique. However, current X-ray absorption spectroscopy techniques falls short when applied to thin samples, or weakly absorbing samples. A recently developed technique, X-ray Phase Fine Structure, overcomes this issue and retrieves the relative complete refractive index of a sample from a single measurement. In this presentation, we discuss details in technique development to achieve an absolute phase spectrum benchmark for theoretical development and to fully understand the extent of applicability.

Influence of paediatric effective diameter on CT dose metrics and size-specific dose estimates (SSDE) value

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Abstract

Children's tissues are susceptibility to radiation exposure and has a higher probability of forming radiation-induced tumours. This study aimed to evaluate radiation dose metrics from paediatric CT chest examination and to compare the influence of paediatric habitus towards size-specific dose estimates (SSDE) value. The data such as volume weighted CT dose index ($CTDI_{vol}$), dose length product (DLP), and demography of paediatric patients were collected retrospectively from Siemens Somatom Definition AS 64-MDCT Scanner located in University Malaya Medical Centre (UMMC). A total of 120 patients were recorded and classified into four age groups (0 - < 1 y/o, 1 - < 5 y/o, 5 - < 10 y/o and 10 – 15 y/o). As recommended by the American Association of Physicists in Medicine (AAPM), we estimate the size specific dose estimates ($SSDE_{AAPM}$) by measuring effective diameter of selected patients. The data were compared with the effective dose (E) and $SSDE_{NCICT}$ obtained from National Cancer Institute Dosimetry System (NCICT). The body mass index and effective diameter was the highest in older age group, which led to the highest output of $CTDI_{vol,}$ DLP and E when compared to younger age group. There is no significant difference ($p > 0.05$) was observed between $SSDE_{AAPM}$ and $SSDE_{NCICT}$ in all age groups. Therefore, radiation exposure was greatly influence by patient effective diameter, scanning acquisition parameter and the optimization technique used during examination.

Evaluation of optimum breast compression, adequate image quality and acceptable radiation dose in digital breast tomosynthesis (DBT) using breast phantom

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Keywords: Digital Breast Tomosynthesis, Breast compression, Image quality, Radiation dose

Abstract

This experimental study is aimed to evaluate the image quality and dose of the breast phantom with different values of compression reductions for medium size of breast in digital breast tomosynthesis (DBT). Exposures were taken with multiple breast compression reductions ranging from 30 lb to 0 lb in cranio-caudal projection using AEC mode. The estimated average glandular dose (AGD) received by the breast phantom was retrieved from the control console. 3 readers with at least 5 years of experiences evaluated the DBT images by using Likert-scale. Spearman correlation test showed a significant inverse relationship between breast compression and radiation dose with excellent correlation ($p<0.01$, $r=-0.997$). 100% sensitivity was found in lesion margin, relative lesion visibility, confidence in classification of lesion, solid mass margin, solid mass relative lesion visibility, confidence in classification of solid mass and number of calcifications from all readers interpretations and the specificity is almost 90%. This study found that DBT was high in sensitivity and specificity in detecting lesion, solid mass, and calcifications except for some reduction to classify the lesions and reduction in number of calcifications in solid masses in 10lb compression. The optimum compression reduction in DBT for medium size of breast is 12lb (4.2 cm thickness) with AGD of 1.32mGy. In conclusion, breast compression in DBT can be reduced up to 60% compression reduction from the original breast compression which helps in reducing the radiation dose at 3.27 mGy.

Task-based assessment of CT performance in CT pulmonary angiography examination using various optimization protocols

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Abstract

The prospective study was designed to identify the relationship between the tube potential, pitch factor and iterative reconstruction (IR) algorithm selection as optimized Computed Tomography Pulmonary Angiography (CTPA) protocols with performance of the task-based image quality assessment. CT quality phantom (Catphan 600) was scanned with a Philips Brilliance 128, USA CT scanner using various CTPA protocol with some alteration of the tube potential and pitch factor. Images were reconstructed with three different level of the iDose[4] as an iterative reconstruction (IR) algorithm (L3, L4 and L5). Images were calculated objectively in terms of contrast to noise (CNR) ratio, noise power spectrum (NPS) and target transfer function (TTF) in different settings of the tube potential, pitch factor and IR algorithm, respectively. CNRs were increased by 30%, 27% and 33% when used lower tube potential, lower pitch factor and high IR algorithm, respectively. However, the NPS shows decreasing in peak frequency about 0.23 mm^{-1} to 0.18 mm^{-1} for increasing IR algorithm, from 0.20 mm^{-1} to 0.17 mm^{-1} for using higher tube potential. TTF indicates increasing in spatial frequency about 0.31 mm^{-1} to 0.34 mm^{-1} and from 0.30 mm^{-1} to 0.33 mm^{-1} for decreasing pitch factor and tube potential, respectively. Hence this study presents a novel technique for characterization of image quality with different type of quantitative measurement for local CTPA protocols.

Radiation doses from CT brain examinations attributes head sizes in a tertiary hospital in Malaysia

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Keywords: Computed Tomography (CT) brain, Contrast enhancement, Dose-length product, Effective dose, SSDE

Abstract

The aim of the study is to evaluate radiation dosage and its relationship with the effective head diameter obtained during CT brain examination performed via a 640 multi-slice CT scanner. Data from a total of 146 patients, who underwent CT brain examinations in our institutions, was collected retrospectively from January 2019 to June 2019. Volume Computed Tomography Dose Index (CTDIvol) value, scanning range, dose-length product (DLP), and diameter of the patient's head based on AP and LAT were recorded in a standardized form for analyzation. Effective dose value (E) and Size-Specific Dose Estimate (SSDE) of patients were determined by multiplying the conversion coefficient (k) obtained from AAPM Report No.96 and AAPM Report No.204, respectively. E and SSDE values are comparable within plain brain CT and contrast-enhanced CT (CECT). The mean Es of the plain brain CT and CECT were 2.02 ± 0.41 mSv and 4.23 ± 0.75 mSv, respectively, and differed significantly with a p-value of less than 0.05. There are no significant differences of E and SSDE in contrast enhancement when compared among genders (p-value > 0.05) and within races for plain brain CT. The radiation doses differed significantly between male (2.08 ± 0.47mSv) and female (1.94 ± 0.31mSv) patients. There is no significant difference in E and SSDE values when compared between genders or races, except for the plain brain CT measured between male and female patients. Thus, extra safety measures should be considered for larger patients to reduce the potential risk associated with CT scans.

Radiation dose measurements for Hysterosalpingraphy in Taif Saudi Arabia

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Keywords: HSG, Radiation Exposure, Patient Dosimetry

Abstract

Hysteromucography (HSG) or uterography is a commonly used diagnostic tool to determine the mucus membrane and uterine tubes. (Infertility) The main purpose of this study is to identify the patients' Entrance Surfaces Doses (ESD), dose effectiveness, and to associate various hospital performances. This study was conducted in the three major hospitals in *"Taif city, KSA"*. *"King Abdul Aziz Hospital* (A)*"*, *"King Faisal Hospital"* (B), and *"Private hospital"* (C). The study was conducted on 100 female patients (aged 23-44 years) for about 6 months. Cal dose-X software was used to find out ESDs. This software needs to record the exposure factors which are *"tube current-time product (mAs)"*, *"tube voltage (kVp)"*, *"focus to skin distance (FSD)"*, and *"tube output"*. For measuring of X-ray tube output with accuracy better than 5% *"Unfors Xi Dosimeter (Unfors Inc., Billdal, Sweden)"* was used. The mean ESD was 20.1, 28.9, and 13.6 mGy, for hospitals A, B, and C respectively.

This study observed that there are broad alternatives in the ESDs among the hospitals under study. Hospital B with values that exceed the values reported internationally. The amount of X-ray descriptions and pictures, the skill of the operator, and the type of X-ray equipment were shown to be the main contributors to the reported variability. The results indicated the need to standardize the technology and introduce the diagnostic reference level throughout the hospital.

Exposure level in Computed Tomography and conventional x-ray for pelvis in Saudi Arabia

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Keywords: X-ray, Computed tomography CT, Pelvis radiation dose

Abstract

The pelvic cavity includes radiosensitive organs that are exposed to different levels of low-dose diagnostic radiation**.** The main aim of the current study was to assess the entrance surface air kerma (ESAK) and effective doses (E), as well as a comparison of pelvis examinations between radiography and computed tomography (CT). The total number of patients included in this study was 313 (age range, 20–89 years). The patients were examined in two hospitals in Taif City, Saudi Arabia (King Abdul Aziz Specialist Hospital [KAASH] and King Faisal Medical complex), designated as hospitals A and B, respectively. Microsoft Excel was used to analyse the results. DOSCAL software was used to assess ESAK and entrance skin dose (ESD) in conventional pelvic imaging, while the CT dose index weighted (CTDIw [usually CTDIvol]) and dose length product (DLP) were utilized to estimate the CT pelvis radiation dose. The mean ESDs for routine pelvis x-ray imaging was 7.2 mGy and the E was 0.38 mSV. The mean CTDIw, DLP, and E were 10.9 mGy, 593 mGy-cm, and 8.9 mSv, respectively. ESD and E were at acceptable levels compared to previous studies. There was a significant variation in radiation dose among the selected hospitals with respect to imaging of the pelvis for conventional radiography and CT. CT irradiated pelvic organs by > 20-fold compared to radiography. Additional studies are warranted to establish local diagnostic reference levels (DRLs).

The superior quantitative analysis of xQuant reconstruction algorithm in SPECT/CT

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Abstract

Iterative 3D OSEM reconstruction in SPECT/CT is well known for excessive image noise and subpar image quality and resolution, increasing potential for error. A novel algorithm, xQuant (developed by Siemens), uses Ordered Subset Conjugate Gradient Maximisation (OSCGM) which enables image quantification assessment such as standardised uptake value (SUV) measurements for reliable disease detection and evaluation of therapy response. As such, xQuant allows for dosimetry measurements, staging and management of diseases, analogous to the PET/CT modality for staging cancers and chemotherapy management. This study aims to verify the accuracy of xQuant algorithm and compare image noise against 3D OSEM, with several quantitative assessments. A standard clinical phantom is used for comparison of both reconstruction algorithms; xQuant SUV accuracy with various Tc99m activity and scan times are analysed along with image noise assessment. Results indicate that SUV measurements from xQuant are similar to expected SUV, regardless of selected reconstruction parameters, varying radiation activity and delayed scan times. Image noise assessment has shown that xQuant has lesser value of CoV compared to 3D OSEM, indicating xQuant's superior noise suppression without compromising image quality. The quantifiable superiority of xQuant reconstruction algorithm supersedes the basic iterative 3D OSEM reconstruction. It shows higher resolution qualitative assessment and provides consistent quantitative analysis. The reliability and superiority of xQuant enables clinical SPECT/CT quantification to detect disease and improve therapy management.

Evaluation of pediatric patients radiation dose and cancer risk associated with Computed Tomography paranasal sinuses

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Keywords: CT angiography, Radiation risk, Effective dose

Abstract

Computed tomography (CT) of the sinuses uses special x-ray equipment to evaluate the paranasal sinus cavities – hollow, air-filled spaces within the bones of the face surrounding the nasal cavity. CT scanning is painless, non-invasive, and accurate. It's also the most reliable imaging technique for determining if the sinuses are obstructed and the best imaging modality for sinusitis. This method is related to high radiation dose, and this has raised serious concerns within the literature. Effective dose (E) may be a single parameter meant to reflect the relative risk from radiation exposure. Therefore, it is necessary to calculate this parameter to point relative radiation risk. This study aims to evaluate child patients' exposure during diagnostic and estimate the radiation risk. A total of 48 child patients was estimated of radiation risk dose for three years, respectively. The patient's exposure was estimated based on a Computed Tomography device's delivered radiation dose (Siemens Somatom Sensation 64 (64-MDCT)). The participating physicians obtained the parameters relevant to the radiation dose from the CT system's scan protocol after each study. The parameters included the volume CT dose index (CTDIvol) and DLP. The CTDI value, which is a basic radiation dose parameter of CT. The mean and range of CTDI and DLP for three respective year was (2018) 9.36 (34.88-3.49), 196.1 (812.1-56.27), (2019) 16.9 (45.8-3.74), 333.9 (832.9-55.8) and (2020) 22.8 (45.8-4.03), 474.9 (979.02-63.9). Therefore, the CT acquisition parameter optimization is vital to reduce the dose to its minimal value. Patients' doses were slightly higher compared to previous studies.

[1] Sulieman et al. (2020) Radiat. Phys. Chem. 168, 1-7

[2] Almujally et al. (2020) J. Clin. Imag. Sci. 10(46), 1-4

Survey of the current CT effective dose and imaging protocols in Saudi Arabia

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Abstract

Medical exposure is the largest source of artificial radiation to the general population. Computed tomography (CT) has tremendous benefits to human health. However, there is increasing concern regarding the risk of this radiation exposure. The objectives of this study are to: quantify the patient dose in CT examination for, brain, chest, abdomen and to estimate the patient's effective dose and radiogenic risk resulted from this imaging procedure. The radiation dose was measured in five radiology department equipped with different CT modalities from other vendors. In this study, the mean effective dose for hospital A was 4.3±1.7 mSv, 20.5±6.6 mSv, and 62.3±32.5 mSv for the brain, chest, and abdomen, correspondingly. The mean effective dose for hospital B was 3.8±1.4 mSv, 28.1±36.5 mSv, 46.2±34.2 mSv for brain, chest, and abdomen. The mean effective doses for hospital C were 2.7±1.4 mSv, 8.5±3.4 mSv, 18.2±13.1 mSv for brain, chest, and abdomen. The mean effective dose for hospital C was 3.2±1.6 mSv, 12.5±9.7 mSv, 36.9±20.6 mSv for brain, chest, and abdomen in that order. The mean effective dose for hospital E was 1.6±0.9 mSv, 3.2±1.8 mSv, 8.7±5.7 mSv for brain, chest, and abdomen. The radiation risk for cancer induction may reach three x10-3. Two departments equipped with 64 CT slices expose patients to higher doses than departments fitted with 16 and pieces. The radiation dose from these procedures is higher compared to previous international studies. A local diagnostic reference level was proposed, and actions were taken to ensure optimum radiation exposure.

Organs dosimetry in targeted radionuclide therapy in Kuwait

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Keywords: Lu-177, Radiation risk, Nuclear medicine, Theranostic

Abstract

Nuclear medicine allows visualization of tumors by an imaging technique after specifically targeting diagnostic radiopharmaceuticals and subsequently treating them with therapeutic radioactive molecules capable of killing the cancer cells. The therapy is performed using ^{177}Lu ((Gamma of 113 keV (6.4%), 208 keV (11%), and beta radiation of 497 keV)) with reasonable half-life (6.64 days). In Kuwait, this is the first study conducted to evaluate the organ doses during theranostic applications. In addition to that, limited data is available regarding radiation protection and safety of peptide receptor radionuclide therapy (PRRT) in this patients and family members. The objective of this study is to assess the patients' effective and organ dose during theranostic applications in Kuwait. A total of 18 patients were undergone theranostic procedures with ^{177}Lu Dotatate in Kuwait Cancer control center. Medium energy collimator was used to acquire images in specific interval time 1-2 hr (before emptying bladder), 6, 24, 48, 72 hr. Organ and total patients' doses were calculated using Organ Level INternal Dose Assessment (OLINDA) Software. The mean effective dose (mSv/MBq) for the left and right kidneys, liver and urinary bladder were 0.61 and 0.60, 0.08 and 0.36, respectively. The overall effective dose (mSv) ranged from 0.55 to 7.7. Lu-177 acquired scans provided diagnosable information's. The patents dose is higher compared to the previous studies. Variation is attributed to the departmental protocol and administered activity. Optimisation of the SPECT/CT imaging protocol is recommended to assure that patients received a minimal effective dose.

Evaluation of patients radiation dose and cancer risk associated with mammography study

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Abstract

Female breast malignancy is a prominent tumor and contributes 25% of cancer incidences in Saudi Arabia, and around 8000 cases are diagnosed annually. In Saudi Arabia, breast cancer occurs in women around the age of 52, and 50–60% of patients are diagnosed at a late stage. In contrast, breast malignancy contributes 55.2% of cancer incidences in women, and half of the cases arise in females above 65 years old in western countries. The incidence of malignant breast tumors will rise in the kingdom in the near future because of the residents' aging, lifestyles, and population growth. Two-thirds of patients with breast cancer were pre-menopausal and the median age was 45 years. The common risk factors include: null parity r pregnancy at late age, menstrual history, obesity, and genetic factors (family history). The patient's exposure was estimated based on a Mammomat INSPIRATION device's delivered radiation dose (Siemens). The average patient age (years) was 49.8 ± 9.4 (20–77). The average and range of exposure parameters were 29.1 ± 1.4 (26.0–32.0) and 147.8 ± 21.2 (28.0–184.0) for X-ray tube potential (kVp) and tube current (mA), respectively. Therefore, the mammography acquisition parameter optimization is vital to reduce the dose to its minimal value. Patients' doses were slightly higher compared to previous studies.

Radiation exposure and establishment dose reference levels interventional for percutaneous coronary interventions procedures

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Keywords: Cardiac catheterization, Radiation risk, KAP meter, Effective dose

Abstract

Repeated radiation exposure increases the risk of deterministic effect (skin injury (>= 2.0 Gy) and the probability of cancer effect. Patients' skin injuries were reported from different countries during cardiac catheterization. Therefore, monitoring of patients' doses is recommended to ensure the patients received a minimal radiation dose. The objectives of this study were to evaluate patients' doses during cardiac catheterization procedures, which include coronary angiography (CA) and percutaneous coronary interventions (PCI) and pacemaker examinations, and to establish a local diagnostic reference level (DRL). A total of 419 patients were examined in four Hospitals in Khartoum state, Sudan. The patient's doses were measured using a Kerma area product meter (KAP). Effective dose was extrapolated using NRPB software. The mean effective dose (mSv) per procedure 5.96, 4.06, 7.00, for CA, PCI, and respectively. While for KAP (mGy.cm2), these corresponding values were 497.86, 308.8, and 601.2. The variances in radiation doses incurred during PCI were greater than the variance in doses incurred in CA and pacemaker due to the clinical complexity involved in the procedure. DRL values derived in this study were comparable with values reported in international literature. The patient's dose is below the threshold of skin injuries. Staff training is recommended to ensure the optimum use of the x-ray equipment to reduce patients' radiation risk.

Characterization of Target Transfer Function (TTF) performances for detection of Pulmonary Nodule in lung from current protocol

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Abstract

The prospective study was designed to calculate the target transfer function (TTF) at different tube potential, pitch factor and iterative reconstruction (IR) algorithm selection for detection of Pulmonary Nodule in lung. An image quality phantom (CATPHAN 600) was scanned with a Philips Brilliance 128 slices, USA CT scanner using local Computed Tomography Pulmonary Angiography (CTPA) protocol with several tube potential and pitch factor settings which are 80,100 and 120 kVp and 0.798, 1.015 and 1.171, respectively. Images were reconstructed with iDose^4 level 2 as a local IR setup and additional of iDose^4 level 3 and 4. Spatial frequency values indicate TTF performance were calculated in different settings of the tube potential, pitch factor and IR algorithm, respectively. TTF performance was relatively higher at pitch factor of 1.015 for every tube potential setting. However, no significant different observed on spatial frequency values for various tube potential and IR settings. The suitable pitch factor setting may enhance the TTF performance for Pulmonary Nodule detection on lung. Thus, this study had revealed a new finding of the TTF characterization for Pulmonary nodule detection in different data acquisition settings for further optimization of current CTPA protocol.

Establishment of diagnostic reference levels for pediatric imaging procedures in the Saudi Arabia

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Keywords: Pediatric imaging, DRL, Effective dose, CT imaging

Abstract

CT represents about 5% of all X-ray imaging, and yet the radiation from CT examination is 70 % of all medical radiation. Pediatric studies constitute up to 10% of the total number of medical radiological examinations. Currently, diagnostic radiological plays an essential role in assessing and treating the patient in modern medicine. The dose from a single CT examination can range from 1.0 mSv to 27.0 mSv. The study's objective was to investigate the dose from CT examination of pediatric patients in CT examination and compare the dose with international stander as provided in DRLs. A total of 135 patients were examined at three radiology Departments equipped with muli-slice CT scanners. 78 (57.7%) of patients were males, and 57 (43.3%) were females. The examined procedure includes CT brain, abdomen, and pelvis. The overall mean age seven years for the brain, the mean weight was 11 kg. The mean DLP for the brain was 362 mGy.cm, 190 mGy.cm for the abdomen, and 215 mGy. cm for the pelvis. The DRL was 1120mGy.cm, a value that is lower than the European Guidelines on Quality Criteria for Computed Tomography. Although patients' doses are within the international levels. The study has shown a great need for referring criteria, continuous training of staff in radiation dose optimization concepts to eliminate the unjustified medical exposure.

Analytical study of radiation shielding plan for hybrid imaging technique (SPECT/CT)

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Abstract

Single photon emission computed tomography (SPECT/CT) is a new technique that plays a key role in nuclear medicine. The use of SPECT/CT and its explosive growth in the number of SPECT/CT scans has increased dramatically and pose a real health hazard to workers and the public. Attenuation of gamma radiation by various locally available shielding materials was measured for ^{99m}Tc, which are often used as radioactive sources in nuclear medicine centers. Shielding requirements are an important consideration in the design of a SPECT/CT imaging facility. The SPECT/CT shielding design includes measuring the dose to occupants and reducing doses to workers and the general public as low as reasonably achievable (ALARA). A radiation survey was carried out on a SPECT/CT machine using a calibrated survey meter. Based on measurements of available shielding materials, a revised shielding design plan was proposed for the console room and hot lab for institute of nuclear medicine oncology and radiotherapy (INOR) Abbottabad, Pakistan.

Assessment of radiation dose around patients in SPECT/CT unit

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Abstract

Single photon emission computed tomography/computed tomography (SPECT/CT) is used in routine clinical practice and provide functional and structural information using dual imaging techniques. SPECT/CT have shown a rapid spread in recent years due to their high sensitivity, specificity, accuracy, more accurate localization and results. Patients are exposed to a higher dose of radiation due to hybrid imaging than patients receiving SPECT alone. The study aims to assess the incremental radiation exposure of patients from clinical SPECT/CT in terms of effective dose. To measure the effective dose received by patients, various SPECT/CT studies were conducted through institute of nuclear medicine oncology and radiotherapy (INOR) in Abbottabad, Pakistan. During SPECT/CT examinations CT dose length product (DLP), computed tomography (CT) dose index and the amount of applied radiopharmaceutical were evaluated. The total patient exposure during clinical SPECT/CT is on average 7 mSv. The contribution of low-dose CT to the total radiation dose to patients undergoing SPECT/CT examinations is relatively small compared to the effective dose from the administration of radiopharmaceutical. Physicians should make every effort to minimize this effect by using proper technical procedures and educating patients about the radiations they will exposed.

Estimation of kidney and bladder radionuclide activity during bone scan

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Abstract

Bone scan using ^{99m}Tc-methylenediphosphonate (MDP) is considered the most sensitive methodology in detection of bone disease especially the bone metastasis. Estimation of radionuclide activity in kidneys and bladder during bone scan is necessary due to associated organ dose and risk of cancer induction through late effect. The objective of this study was to estimate the radiation dose to the kidney and bladder from injection of ^{99m}Tc-MDP and compare the result to that established theoretically using nuclear medicine MIR Dose. The whole-body bone scan acquired 2 to 4 hours (3-hour average) post injection of ^{99m}Tc-MethylineDiPhosphonate MDP). Quantitative analysis was performed on patient data by drawing a region of interest (ROIs). The number of counts registered was converted to mCi radioactivity. 3 hours post injection of ^{99m}Tc-MDP, less amount of radionuclide activity was found in the kidney (0.039 ± 0.011 mCi) compare to the bladder (0.141 ± 0.079 mCi), this value is equal approximately to 0.2% for the kidneys and 0.7% for the bladder percentage fraction of injected dose to the patients. The result of this study find that the experimental estimated dose is smaller than the theoretical values issued using MIR Dose, also the result found that approximately 0.9% of the injected dose to the patient remained in both kidneys and bladder at 3 hours post radiopharmaceutical administration. The study found that less than 1% of the total dose injected affect the kidney and bladder, thus the radiation induced stochastic effect being less probability.

Vascular lower extremity angiography multi-phase exposure: Assessment of radiogenic risk and dose reduction techniques

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Abstract

In Sudan and over the past five years, there has been a rapid growth in both the number of diagnostic x-ray units and the medical procedures that utilize ionizing radiation. One of the most significant potential risks to patients examined with CT is an increased probability of cancer induction. CT angiography multi-phase exposure for the lower extremity expose the patients to high radiation dose and might surpass the levels known to increase the possibility of malignancy. This study aiming Evaluate of patient's effective dose during lower limb angiography CT scan, estimate radiation risk and establish local diagnostic reference level for the CTA procedures. A total of 125 patients were examined (76 (60.8%) males and 46(39.2%) females) in five hospitals equipped with modern CT machines 64 to 160 slices. Patient effective radiation doses were assessed using ImPACT software. The mean and range of patient age (years) was 65 (40-84). The mean± standard deviation, range, median, 3rd quartile, and range of patient dose in terms of dose length product (DLP) (mGy.cm) were 5238.2±748.6 (4333.9-8228.5), 5092.9, and 5348.3, respectively. Volume CT dose index (CTDIvol (mGy) ranged from 16.2-908.9). The mean and range of effective doses per procedure were 31.4 ± 5 mSv and 26.0–49.3 mSv. The risk of malignancy is one per thousand procedures. The radiation dose from these procedures is higher compared to previous international studies. A local diagnostic reference level was proposed was established for further dose reduction.

A lanthanum-barium-borovanadate glass containing Bi_2O_3 for radiation shielding applications

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Keywords: Bi_2O_3, Radiation shielding, Borovanadate glass, Gamma-rays, Phy-X/PSD

Abstract

Radiation shielding materials are of prime importance for weighing benefit-to-risk of ionizing radiation. In this perspective, a lanthanum-barium-borovanadate (LBBV) glass system containing varying amounts of bismuth oxide (Bi_2O_3) is studied in this work. The glass composition of $5La_2O_3$-10BaO-(65-x)B_2O_3-$20V_2O_5$-xBi_2O_3 where x: 0, 3, 6, 9, 12, 15 mol% has been purposed, and thus 6 different glass series with LBBV-0 to LBBV-5 coded were investigated for the physical, mechanical, and radiation shielding features. Physical property calculations revealed that the glass density increase from 3.1685 to 4.1345 $g.cm^{-3}$ with the insertion of Bi_2O_3 from 0 to 15 mol%. Furthermore, mechanical properties in terms of the Mackenzie-Makishima model demonstrated that Young's, bulk, shear, and longitudinal moduli were enhanced following the concentration of Bi_2O_3. In particular, the LBBV-5 sample showed the best mechanical moduli amongst others. Radiation shielding competencies were ascertained by using newly-developed Phy-X/PSD and Monte Carlo N-Particle Transport Code (MCNP-5). The theoretical computations via Phy-X/PSD clearly indicated that the linear attenuation coefficient (LAC) showed enhanced characteristics with the increasing content of Bi_2O_3. Based upon the determined LAC, the other essential parameters such as half-value layer (HVL), mean free path (MFP), radiation protection efficiency (RPE), and transmission factor (TF) were also assessed. Moreover, the MCNP-5 simulation revealed that the LBBV-5 sample provided the best radiation shielding features compared to the undoped LBBV-0 one. Moreover, both Phy-X/PSD and MCNP5 studies displayed good agreement with each other. Overall, it can be concluded that Bi_2O_3 seems to be a strong candidate for improving radiation attenuation coefficients in the LBBV glass system.

A novel P_2O_5-CaO-Na_2O-$_2O$-PbO glass systems for radiation shielding in dental applications

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Abstract

Achieving an accurate and efficient protection from X-rays which are widely used in the medical and dental applications is ever demanding. Despite the usage of several materials as shielding materials to protect the human and the medical equipment from the X-ray, dedicated efforts are in progress in promoting novel shielding materials having better performance. The main objective of this investigation is to understand the interaction mechanism of the X-rays that are used in dental diagnosis with bioactive glass when used in dental applications, and to report the X-ray attenuation parameters of these bioactive glasses. For this purpose, the well-known melt quenching method was used to prepare five glass samples with the composition of (40)P_2O_5-20CaO-(30-x)Na_2O-10K_2O-(x)PbO, where x= 0, 5, 10, 15 and 20 mol%. The XRD and FTIR were used to ensure the amorphous state of the prepared samples. The X-ray interaction parameters for different bioactive glasses are studied using FLUKA simulation code at some dental diagnosis energy (between 20-190 keV). The obtained FLUKA results were compared with theoretical data (i.e. Phys-X and XCOM), which conforms the accuracy of our results. Additionally, the transmission factors are evaluated for the bioactive glasses. The X-ray attenuation features of the selected bioactive glasses are compared with those of standard bioactive glasses at the energy values under study.

Fabrication and radiation shielding features of a novel bismuth-doped barium borate glass system

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Abstract

The study of glasses features such as mechanical, optical, and radiation shielding properties is one of great significance, Due to their potential applications in various engineering and technological fields. The present study presents a new trenery glass series fabricated as a mixture of $60B_2O_3$-(40-x)BaO-xBi_2O_3, x=0, 2.5, and 5 wt%. The fabricated glass density increased from 3.148 to 3.281 g/cm^3, while the molar volume decreased from 28.287 to 25.845 cm^3/mol, increasing the Bi_2O_3 insertion ratio between 0 and 5 wt%, respectively. The mechanical features and elastic moduli of the fabricated glass samples were evaluated utilizing the Makishima-Makenzie (M-M) model Moreover, the experimental measurement, Monte Carlo simulation code (MCNP-5 code), and other theoretical programs such as XCOM and BXCOM were used to evaluate the fabricated glass samples' radiation shielding properties. The experimental LAC values at 0.662 MeV varied between 0.2658, 0.2743, and 0.2843 cm^{-1}, with increasing the Bi_2O_3 ratio between 0, 2.5 and 5 wt%, respectively.

Studies of physical behaviors of some boron containing resources and nuclear radiation rays

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Abstract

Due to the large neutron capture cross-sections of ^{10}B isotope, the basic physical behaviors of some boron containing resources (sample code B1-B6) for shielding of neutron (thermal and fast) and photons were investigated through theoretical calculation and experimental testing in this paper. Neutron (thermal) shielding features of B1-B6 samples is mainly contributed to by the absorption cross section of ^{10}B isotope, which is positively correlated with the boron content, also elastic cross section of the element with high content or cross section has some contribution. About fast neutron shielding, it depends on the elements with high content and cross section, which is positively correlated with density. About gamma ray shielding, it depends on the element with high content and atomic number, which is positively correlated with density. Comprehensive shielding performance of B1-B6 found to be better than the ordinary concrete and some commercial materials. The test results of composites prepared by boron (B1-B6) and epoxy resin for neutron and gamma ray show that the composites has excellent shielding performance for neutron but poor for gamma rays. What's more, boron rich slag will be the best one for both neutron and gamma ray shielding. The work will be useful for the potential applications boron containing resources.

Radiation shielding and mechanical properties of Bi_2O_3-Na_2O-TiO_2-ZnO-TeO_2 glass system

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Abstract

Recently, heavy metal oxides (HMO) based glass systems attracted great attention to the scientific community to be used as an alternative to the conventional lead, lead composites and concrete based materials for protection of harmful radiation. In this work, we report the role of Bi_2O_3 on the mechanical and radiation shielding properties of Bi_2O_3-ZnO-TiO_2-Na_2O-TeO_2 glass system as well as its mechanical behaviour. The mechanical properties of the glasses were calculated using Makishima-Mackenzie model and different shielding factors have been calculated using Monte Carlo simulation via Geant4 code and also using Phy-X software. The mechanical properties based on Makishima-Mackenzie model depend on the values of packing density (Vi) and dissociation energy (Gi) of the oxide constituents. The simulated values of the mass attenuation coefficient showed a good agreement between both approaches. The transmitted percentage of the photons through the proposed glasses was found to increase with increasing the energy of the photon, while decreasing with increasing the thickness of the glass sample. Also, the radiation protection efficiency of the glasses was enhanced with the addition of the Bi_2O_3. The glass sample with composition of $15Bi_2O_3$-$10ZnO$-$5TiO_2$-$5Na_2O$-$65TeO_2$ possesses the highest effective atomic number among the studied compositions and showed the lowest half value layer. From the obtained data, Bi_2O_3 seems to be a strong candidate for enhancing the gamma radiation attenuation factors in the bismuth-based tellurite glasses.

Gamma ray shielding and thermoluminescence investigation of bismuth added heavy metal oxide glasses

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Abstract

Nowadays, as a replacement for lead which is a toxic element, bismuth glasses are explored extensively due to their higher density for radiation attenuation applications. This work is an attempt to portray the radiation shielding and thermoluminescence response of bismuth in the borosilicate glass composition of (60-x) B2O3- 20SiO2- xBi2O3- 12ZnO- 8BaO with x = 0, 2, 4, 6, 8, 10 and 12 mol%. The estimation of theoretical values of gamma shielding parameters with 137Cs gamma source such as mass attenuation co-efficient (MAC), effective atomic number (Zeff), half value layer (HVL) and mean free path (MFP) was carried out using Photon Shielding and Dosimetry software and compared with the experimental results. The data naturally showed higher attenuation values for ZBiB-12 glass. Higher bismuth samples were observed to have dark brown colour and opaque nature. The applicability of such glasses for gamma dosimetry using thermoluminescence (TL) property was also examined by irradiating the glasses with 5 kGy of 1.25 MeV gamma radiation from 60Co source. The radiation created defect centres by breaking Zn-O, Bi-O, Si-O, B-O and Si-O-B bonds resulting in high intensity TL peaks. The role of Bi as TL quenching agents has been evaluated in this study. Computer Glow Curve Deconvolution was done for the TL curves to get the information regarding trapped charges such as activation energy, half-life and frequency factor. Among the bismuth incorporated samples, ZBiB-8 sample exhibited comparably higher TL intensity at 577.4 K, giving higher half- life value of 87 years.

The presence of primordial radionuclides in powdered milk and estimation of the concomitant ingestion dose

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Abstract

The present study determines the concentrations of primordial radionuclides in powdered milk samples collected from the local markets of Dhaka city in Bangladesh using HPGe γ-ray spectrometry. The mean activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K for infant (8.97 ± 2.10, 9.59 ± 1.53 and 164.47 ± 3.72 Bq kg^{-1}, respectively) found to be relatively higher than the people of all other ages (7.16 ± 3.72, 7.42 ± 1.46 and 143.16 ± 3.87 Bq kg^{-1}, respectively). Based on the typical consumption characteristics of powdered milk, the mean annual effective doses for infant (<2 years), children (2-7 years, 7-12 years and 12-17 years) and adult (>17 years) were estimated to be 297.47, 140.56, 141.63, 198.53 and 130.63 μSv y^{-1}, respectively, which are lower than the FAO/WHO and ICRP (2007) recommended limit of 1.0 mSv y^{-1} for public exposure of all ages. On the other hand, the doses for infant exceed the UNSCEAR (2000) reference ingestion dose constraints of 290 μSv y^{-1}, which indicates a non-negligible concern for the infant's health. The carcinogenic risk due to the ingestion of radionuclide show in the range of 1.88×10^{-4} - 2.67×10^{-4}, an order of 2 lower than the ICRP (2013) cancer risk factor of 4.5×10^{-3}, thus discarded the radiation hazards via the consumption of local or imported powdered milk in Bangladesh. Overall, the measured data may help to establish national rules and regulations on powdered milk relating to radiological protection for the general people of Bangladesh.

Radioactive material in the cosmetic and healthcare products: A review on the regulatory controls

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Keywords: Cosmetic, Healthcare, Consumer Products, Regulations, Radiation Protection

Abstract

A wide range of cosmetic and healthcare products containing radioactive substances are easily accessible in the market. The acknowledgement of radioactive substances within this type of consumer product were lacking, thus lead to possible harm that could arise from exposure to radiation in the circumstance of inappropriate use. As such, it is important to ensure that the radioactivity in cosmetic and healthcare products is as minimal as possible. Therefore, the product should be inspected and certified at manufacturing stage before been supplied to the public. This precaution is crucial to reduce the radiation risk encounter by an individual, thus if this product were mishandled, it will only be classified as household waste. Subsequently, no strict regulatory guideline is required to protect the community from excessive exposure to radiation resulting from this product. Based on published data from European and Asian countries, the paper reviews the cosmetic and healthcare products incorporated radioactive substance including their effective dose. The reported and analysed information concerned the progeny of the primordial radionuclides ^{238}U, ^{232}Th, and ^{40}K, along with many other radionuclides. Activities for ^{226}Ra, ^{232}Th and ^{40}K are found to encompass a comparatively large range of values in the different cosmetic and healthcare products. Thus, standard and protection regulations have been implemented in many countries, normally with authority over the extent of exemptions for radioactive materials in cosmetic and healthcare products. In the absence of harmonized regulations, transnational transportation and the use of such cosmetic and healthcare products would remain a great worldwide concern.

Recent developments in optical fiber radiation dosimetry

H.A. Abdul-Rashid, A. Oresegun, A. Basaif, H.T. Zubair, D.A. Bradley

Abstract

Recent developments on Silica Optical Fiber based Radiation Dosimetry, particularly from the consortium of Multimedia University, Sunway University and University of Surrey is presented. The talk covers techniques involving Radioluminescence for applications in NORM monitoring, radiotherapy, diagnostic imaging and industrial radiation. Besides these techniques, some recent developments in time-resolved radiation dosimetry for quality assurance purposes. The talk emphasises on the choice of dopant materials and the electronics to support time-resolved radiation dosimetry. Future direction in neutron detection using Borosilicate glass is also deliberated.

Ge doped fiber for time resolved radiation dosimetry

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Abstract

Time-resolved radiation dosimetry applications related to radiotherapy have clear importance in determining the quality delivery of patient prescribed doses. Earlier reports on doped Silica optical fiber as scintillators in Radioluminescence based radiation dosimetry have indicated merits in its versatility, robustness, high spatial resolutions, wide dynamic range and ability for real-time measurements. However, time-resolved radiation dosimetry requires higher temporal resolution that is enabled by a suitable scintillator (with rise and decay time 5 times shorter than the LINAC pulses rise and fall time) and high-speed electronics (with gating time 10 times shorter than the LINAC pulse width). In this paper, we report the potential use of Ge-doped optical fiber as a suitable scintillator used in a time-resolved radiation dosimetry system. The time resolved performance of the sample, in terms of the fluorescence lifetime, rise and decay time was observed and compared to another sample, P-doped optical fiber. High-energy clinical X-ray beams (6 MV and 10 MV) were used to irradiate the optical fiber, RL response being recorded for six dose-rates (between 100 MU/min and 600 MU/min) delivered by a Varian 2100 C/D linear accelerator. The photon counting circuit's gating time was set at its shortest, 50 microseconds. The Ge-doped optical-fiber scintillator showed linear RL response, with minimal observable memory and afterglow and plateau effects. The rise and fall time of the Ge-doped optical-fiber scintillator indicated superior performance compared to the P-doped scintillator. These results indicate the potential for the Ge-doped optical-fiber scintillator to be used in a time-resolved radiation dosimetry system.

Radioluminescence of silica optical fiber for industrial radiation dosimetry

A. Oresegun, H.T. Zubair, D.A. Bradley, H.A. Abdul-Rashid

Abstract

We present a study of Silica Optical Fiber as scintillators for Industrial Radiation Dosimetry using Radioluminescence (RL). Using the RL technique would facilitate a real-time dosimetry measurement in such a high dose environment. The objective of the study was to establish the performance characteristics of Ge-doped Silica Optical Fiber with varying dopant concentration (6 mol% and 10 mol%), geometries (flat and cylindrical) and core diameters (between 100 to 660 micrometers). The samples were exposed to a linear accelerator in the order of tens of kGy (from 10 kGy through 70 kGy in individual exposures). The performance parameters observed during the study include the RL emission spectrum, RL emission intensity, RL emission linearity with exposure dose and repeatability. The RL spectrum demonstrated a central wavelength of 650 nm with its intensity increasing with exposed dose. The RL intensity increased with exposed dose as a result of ionizing radiation generated electron-hole pairs recombining. The RL intensity relation with exposed dose indicated a linear fashion with the 6 mol% sample showing the greater slope, indicating greater sensitivity. The overall results indicate the potential use of Silica Optical Fiber as scintillators for real-time Industrial Radiation Dosimetry.

A modified prompt gamma-based neutron dose measuring system

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Abstract

Estimation of neutron dose in any workplace of mixed radiation environment is an important and challenging research activity. Measured neutron induced prompt gamma intensities from a system composed of high-density polyethylene (HDPE) and borated HDPE (BHDPE) have been established in earlier research for neutron dose estimation. The difficulties associated with discriminating and quantifying the boron prompt gamma intensity (0.487 MeV), strongly affected by the annihilation peak (0.511 MeV) are eliminated by replacing boron (B) with cadmium (Cd) in the proposed system. In this configuration, a solid cadmium cylinder covered by HDPE (containing hydrogen and carbon) is used as the prompt gamma generator when irradiated with neutrons. The dimensions of the cadmium cylinder and the HDPE cover are optimized for compactness and neutron response. The responses (prompt gamma emission probability) of the system for mono-energetic neutrons of different energies are computed using the Monte Carlo code FLUKA. The prompt gammas emitted from HDPE (2.2 MeV from hydrogen, 4.43 MeV from carbon) and cadmium (1.48 MeV and 1.66 MeV) as measured using a NaI(Tl) detector are considered in the simulation. The calculated responses are fitted using multiple linear regression method with the fluence to dose conversion coefficients (DCC) as provided by the International Commission on Radiological Protection (ICRP) to estimate neutron dose from measured prompt gamma intensities.

Salty crackers as dosimeters in radiological and nuclear emergencies: improving sample preparation

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Abstract

When a radiological or nuclear (R/N) emergency occurs, the categorization of individuals into those who are unaffected and those requiring medical intervention is a high priority. At times, a professional dosimeter is not available and therefore some common belongings may be used as fortuitous dosimeters. The preparation of these objects for the measurement should be such as to give the most accurate results.

This paper confronts the problem of choosing the right method for preparing the samples from salty crackers which are meant to be analyzed by photo-stimulated luminescence (PSL) technique. The crackers were crumbled into three different sizes: bigger pieces (about 1 cm), medium pieces (about 0.5 cm), and completely powdered. The precision of the results obtained for each type of sample preparation were compared for infrared (890 nm), blue light (470 nm) and combined stimulation, but also studied for two different masses of the samples (1 g and 2 g). The measurements were performed both on unirradiated crackers and irradiated ones (1 Gy).

The study was simultaneously conducted by two laboratories (Ruđer Bošković Institute, Croatia and Istituto Superiore di Sanità, Italy) involved in a project (grant No. G5684) supported by NATO Science for Peace and Security Programme.

Neutron irradiation effect on structural and optical properties of gadolinium-doped silica glass

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Keywords: Neutron irradiation, Dosimetry, Gd-doped silica glass, Sol-gel method

Abstract

Recently, growing attention has been paid to glass containing rare earth due to their interesting physical and chemical properties for many applications. Among various inorganic hosts, silicate glass host are known as excellent host materials for many technological applications due to its outstanding chemical, physical, thermal and high irradiation power stability making them excel as scintillators in medical, industry and radiation sensor. Thus, an investigation was performed on Gadolinium-doped silica glasses prepared by sol-gel method in the concentration range of 1-10 mol% Gd for neutron radiation dosimetry application. The analyses were carried out as a function of Gd content, before and after neutron irradiation. The sample were exposed 1 to 10 minutes with ^{241}AmBe source to obtain fast neutron interaction. The structural and optical properties of Gadolinium-doped silica glass with neutron irradiation have been investigated by Raman spectroscopy, photoluminescence, and X-ray diffraction. The structural change due increasing gadolinium concentration has been analysed. In condition of irradiation, the formation of point defect and microstructure change has been identified. Present work constitutes of preliminary results of an effort undertaken to evaluate the potential of Gd^{3+}-doped silica glass as neutron radiation dosimetry.

Hexagonal boron nitride nanoparticles: A potential material for solid-state neutron detector

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Abstract

Hexagonal Boron nitride nanoparticles (BNNPs) with enriched Boron (^{10}B) contents are synthesized with Argon-supported chemical vapor deposition (CVD). The synthesized BNNPs is a wide band gap semiconductor with a band gap of ~ 6 eV. ^{10}B in the synthesized BNNPs has a larger cross-section (3840b) for thermal neutron. Thermal neutron by the interaction with the synthesized BNNPs can produce ^{7}Li and ^{4}He charged particles. The as-produced charge particles while moving in the BNNPs generate electron-hole pairs. The detection of these pairs by their respective electrodes indirectly corresponds to neutron detection. The synthesized BNNPs can thus be sought as a potential material for the development of a solid-state neutron detector.

Investigation of scattered dose in a mouse phantom for pre-clinical dosimetry studies

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Abstract

Tissue-equivalent phantoms are suitable tools for radiation dosimetry investigations. The goal of this study was to measure and calculate the absorbed dose in a breast tumour model and in adjacent normal tissue of a mouse by means of a Polymethyl Methacrylate (PMMA) mouse phantom and employing Monte Carlo (MC) simulations. The phantom mimics the characteristics of tissue and approximated shape of body and tumour of a tumour-bearing mouse. The mouse phantom was positioned in a novel add-on collimator, designed by our research group[1], to enable targeted irradiation using a ^{137}Cs radioactive blood irradiator. The mouse phantom was irradiated targeting the tumour with a dose of 12 Gy. Radiochromic film was utilized to measure the dose distribution within the phantom. EGSnrc MC code was used to simulate the irradiation system and calculate the 3D dose distribution in the mouse phantom for comparison with the film measurement. The normal tissue dose measured with the film dosimeters was between 7 to 9% of the tumour dose. Also, an excellent agreement between scattered dose measurements and simulation results was observed. The results demonstrate that our physical phantom is a useful tool to study the doses of the individual tumour and normal tissue of a mouse. This is also a useful measurement tool to validate complex computational models.

1. Fontanarosa, D., Benitez, J., Talkhani, S., Fielding, A., Entezam, A., Trapp, J., ... & Mazzieri, R. (2020). A novel add-on collimator for preclinical radiotherapy applications using a standard cell irradiator: design, construction, and validation. *Medical physics*, 47(6), 2461-2471.

Solar activity cycles recorded in long-term data on tritium activity concentration in precipitation at Zagreb, Croatia

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Abstract

Radioactive isotope of hydrogen, tritium (^{3}H), with the half-life of 12.32 years, is of both cosmogenic and anthropogenic origin. As a part of tritiated water, H^{3}HO, it enters the natural water cycle. Massive injections of anthropogenic ^{3}H from weapons tests in the 1950s and 1960s caused an almost 1000-fold increase in the tritium activity concentration in precipitation, known as the "bomb peak". After the cessation of atmospheric nuclear weapons tests, a gradual decrease in ^{3}H activity concentration in precipitation was observed worldwide approaching presently the natural pre-bomb level.

Monitoring of tritium activity concentration in monthly precipitation at Zagreb (Croatia) has been continuously performed since 1976. Seasonal variations were superposed on the basic decreasing trend of mean annual values until approximately 1996. Between 1996 and 2019 no significant decrease has been observed, while seasonal variations remained observable, with winter activities close to the natural pre-bomb ^{3}H activity concentrations.

Tritium has been widely used for studying time scale of hydrologic processes in the last decades of the 20th century. Its present scientific value for hydrological applications has significantly declined. On the other side, prevailing anthropogenic tritium in precipitation before 1996 prevented studies on whether the natural production of (cosmogenic) tritium was influenced by variations in solar activities. Our long-term data were evaluated by applying frequency analysis together with wavelet analysis. Both mathematical methods gave strong evidence of the correlation of tritium variation in precipitation with the 11-year solar cycle and so neutron flux. These findings support evidence of solar influence on meteoric tritium.

Assessment of natural radioactivity and radiological risks from groundwater and vegetation samples collected from farms in Qatar

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Abstract

Over the last decade, the quality of groundwater in Qatar has been observed to show substantial deterioration in their quality and quantity following the overconsumption of groundwater in agriculture at rates way higher than the natural replenishment rate. This resulted in a drop in the water table to an unprecedented level. In the present work, the radioactivity analysis of groundwater and vegetation collected from three Qatari farms was conducted. The activity concentration of ^{226}Ra, ^{228}Ra and ^{40}K in the collected vegetation was measured using high purity germanium detector (HPGe). Moreover, the radiological risks were evaluated by estimating the average annual effective dose due to the intake of the above-mentioned radionuclides through ingestion of vegetation samples. The average activity concentration (dry-weight) of ^{226}Ra, ^{228}Ra and ^{40}K in Rocca were: 84.4 ± 1.4, 3.05 ± 0.32 and 1730 ± 72, respectively. The average activity concentration (dry weight) of ^{226}Ra, ^{228}Ra and ^{40}K in Corchorus were: 111 ± 2.15, 5.1 ± 0.53 and 1800 ± 75, respectively. Qatar follows the Gulf Cooperation Council (GCC) Standardization Organization (GSO) limit which states that the total activity level permitted in food products (wet weight) shall not exceed 75 Bq/L (GSO-998/1998). While the activity level of these radionuclides were found to be within the acceptable level, such levels are quite high, when compared to other countries, and attract the scientists to carefully investigate the sources, fate and impacts of such levels on human and environment.

Impact of gadolinium weight percent and the number of its fuel rods on the neutronic and safety parameters in a fuel matrix

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Keywords: Gadolinium, Neutronic, Reactivity, Safety parameters, Small modular reactor, Thorium

Abstract

The impact of gadolinium at different weight percent (w/o) in comparison to the number of its fuel rods on the neutronic and safety parameters of (Th, U)O_2 fuel was investigated. The large reactivity swing curve in the authors previous study in which a unit w/o of gadolinium but different number of gadolinium fuel rods were used motivated this work. The MCNPX 2.7 integrated with CINDER90 fuel depletion code was used. The result showed that the k-infinite and reactivity swing peak decreased with increasing gadolinium w/o, with the highest and lowest k-infinite recorded in the fuel assembly (FA) containing zero (0) and 12 w/o gadolinium, respectively. The largest and lowest reactivity swing curve occurred in the FA with 3.6 and 12 w/o gadolinium at ~ 15 and ~ 35 GWd/tHM, respectively. It showed that the impact of gadolinium w/o and the number of gadolinium fuel rods on k-infinite followed similar trend. Conversely, the reactivity swing curve flattened with increasing gadolinium w/o but increased with increasing number of gadolinium burnable absorber fuel rods. The results showed that ~ 44% and 35 to 42% of ^{235}U were utilised in the FA without and with gadolinium respectively. These phenomenal variations suggest that flat reactivity swing and power control can be achieved within 9.2 to 12 w/o gadolinium.

A study on leaching of primordial radionuclides to water bodies

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Keywords: Thorium, Potassium, Leaching, Gamma ray spectrometry, pH, Surface soil

Abstract

Leaching is a process of extraction of a substance from a solid material when it is dissolved in a liquid. The migration and retention of radionuclides is a geochemical process involving the interaction of local ground water with solid components**.** The main compounds on the surface of minerals can be dissolved. The physical movement of water can dislocate and move particles. India is one of the countries in the world having vast reserves of radionuclides. That occurs in many forms in different regions of Rajasthan, Bihar, some parts of the Himalayas, Andhra Pradesh and in monazite sands along Kerala coast. Beach sands of the coastal territories of Kerala and Tamil Nadu in India are very rich in monazite containing 8-10.5 % of thorium (as ThO_2), 0.2 -0.4% of uranium (as U_3O_8) and K-40. When the soil containing mineral comes in contact with the waterbed, there will be leaching of minerals including radionuclides. In the present investigation, we have studied the extend of leaching of surface soil-borne Thorium and Potassium into water in various pH conditions.

Inhalation dose in the indoor environment of Eloor Industrial Area, Kerala

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Keywords: Radon progeny, Thoron progeny, PAEC, Annual Effective Dose

Abstract

Radon (^{222}Rn) and Thoron (^{220}Rn), the members of Uranium and Thorium decay series respectively, are ubiquitous in nature. Being airborne alpha active radio-isotopes, they can contribute a great amount of inhalation dose especially in the indoor conditions. The objective of the present study was to measure the Potential Alpha Energy Concentration (PAEC) of radon/thoron progenies in the dwellings of Eloor Island, an industrial region in Kerala and thereby evaluate the internal dose to the population due to the inhalation of radon/thoron and their progeny. Aerosol samples were collected from 100 locations in the study area using high volume air sampler and gross particulate activity measurement was done using ZnS(Ag) alpha counter. The PAEC of radon progeny in the study area varied from 0.13 to 2.94 and that of thoron progeny varied from 0.3 to 7.7. It has been seen that the dwelling with marble floor relatively higher concentration of radon and thoron progenies while lower concentrations were observed in dwellings with tile floors. Taking the mean concentrations of ^{222}Rn and ^{220}Rn progeny levels of 100 samples collected, the inhalation dose was 0.14 mSvy^{-1} for radon and 0.09 mSv y^{-1} for thoron, which delivers a total inhalation dose of 0.23 mSv y^{-1} to the population residing in that area.

Correlation between Radium and Radon Exhalation from building materials

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Keywords: Building Materials, Radon, LR-115, Gamma ray Spectrometer Passive method

Abstract

Along with Uranium, radium is also a ubiquitous element in natural materials. Building materials are the second important source of radioactive radon in the indoor environment. In the present study the extend of correlation between radium content in the most widely used building materials with the radon exhalation has been attempted. Radium content in the samples of building materials (Portland cement, white cement, gravel, gypsum, granite, marble, vitrified tile) collected from Kollam and Thiruvananthapuram districts of Kerala, India were assessed using NaI(Tl) based gamma ray spectrometer. The radon mass exhalation rate from powdered building materials and radon surface exhalation from slab type building material were find out using passive technique which is most suitable for time averaged measurements. It is clear from the present results that the highest value of radon mass exhalation rate in building materials was from the samples of grey cement and the minimum exhalation rate was for samples of gravel (red earth) from the samples of building materials studied in powder form. In the case of slab materials, brick has maximum radon surface exhalation rate and it can be attributed to higher porosity of brick as compared with other samples such as granite, marble and vitrified tile. Good correlation was observed between the radium content of powdered samples and their radon mass exhalation rates. For slab type building materials, radium content and radon surface exhalation rate was found to have week positive correlation. Detailed discussion including the physical properties like density and porosity will be made.

Validation of ROOT and R Packages in performing for gamma-ray spectrum analysis

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Keywords: Radioactivity, ROOT, R, TSpectrum, Gamma-ray Spectrum Analysis, HPGe

Abstract

Radioactivity quantification of gamma-ray emitter radionuclides in samples measured by HPGe gamma spectrometers relies on analyzing the photopeaks present in the spectra, especially on the accurate determination of their net areas. TSpectrum Class or Peaks, in the ROOT and R data analysis framework, [1, 2] is a tool for gamma-ray spectrometry. It performs spectral analysis, including peak search, radionuclide identification, and radioactivity determination in samples, allowing full user-defined customization and parameters setting. This study presents the performance of TSpectrum Class for the peak search and analysis to obtain the relevant peak parameters and their uncertainties. The detailed performance of nuclide identification and activity determination was accessed using the IAEA 2002 set of test spectra. By analyzing the test spectra, the numbers of radionuclides identified truly (true hit), falsely (false hit), or missed (misses) were counted and compared with the results of the IAEA 2002 tests from the commercial software packages (Genie 2000, Gamma Vision, Gamma-W, and Inter-Winner). The determined activities of the radionuclides were further compared for four test spectra of several samples. Results obtained correspond to those obtained with the package above, suggesting that it could be safely used in general-purpose gamma-ray spectrometry.

Acknowledgments:
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[1] https://root.cern.ch/doc/v614/classTSpectrum.html (Accessed Jan 2021)
[2] https://www.rdocumentation.org/packages/Peaks/versions/0.2 (Accessed Jan 2021)

Assessment of radon in domestic water resources in South West Coastal of Peninsular Malaysia

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Keywords: RAD7, Radon concentration, Annual effective dose

Abstract

One of the main sources of public exposure from natural radioactivity is radon. The aim of this study is focused on determining the concentration of mentioned radionuclides in the domestic supplies of water resources at South West Coastal of Peninsular Malaysia. Total of twenty seven samples of water were taken from various water resources such as hot spring, groundwater, tap water, lake, river and sea water were collected for the measurement of radon concentration by using RAD7 detector. The concentration of radon was measured in range of 0.07 $\pm$ 0.12 to 186.5 $\pm$ 12.18 Bq l^{-1} with an average value 21.21 $\pm$ 12.18 Bq l^{-1}. Besides that, the concentration of radon based on the categories of water resources found that the highest concentration of radon was determined in hot spring water with the average concentration 98.56 $\pm$ 5.88 Bq l^{-1} and the lowest was found in tap water with average 1.95 $\pm$ 0.61 Bq l^{-1}. Overall, the average concentration of radon in all categories of water resources were found below than 100 Bq l^{-1} as the safe limit for drinking water setup by WHO. Thus, the total effective dose from the summation of ingestion and inhalation dose is 4.45 µSv y^{-1} and that value is much lower than 0.1 mSv y^{-1} as the recommendation dose for drinking water by WHO. At last, the results provided in this study can be very useful to publics for their future reference.

Natural radioactivity in the prospecting tunnel in Egypt: Dose rate and risk assessment

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Keywords: Gamma, U-Mining, Spectrometer, Activity, Radium equivalent, Annual dose

Abstract

Radioactivity levels, dose rate and radiological health risk were assessed in the prospecting tunnel (El-Missikat). A portable gamma spectrometry was used to detect the content of radionuclides are associated with the granites. The monitoring stations were selected in the various drafts of the tunnel. The results showed the mean activity concentrations of ^{238}U, ^{232}Th and ^{40}K are higher than the recommended worldwide average at all monitoring stations in the tunnel. Three radiological indices: radium equivalent (Ra_{eq}) activity, absorbed dose rate (Dair), annual effective dose (AED) were detected based on the activity concentration of radionuclide in the tunnel. The annual effective dose was contributed from gamma radiation is 1.98 mSv that is lower than the recommended limit of 2.54 mSv, so no significant dose.

Obtaining a precise SOBP profile in the thyroid cancer therapy using SDTrimDP code

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Keywords: SOBP, Thyroid Cancer Therapy, SDTrimDP, SRIM/TRIM

Abstract

Proton beams are also being studied in radiotherapy to achieve optimum therapeutic effects, have a lethal effect on the tumor tissue, and protect the healthy tissue around it. It was based on traditional codes such as SRIM/TRIM, FLUKA, and PHITS to achieve a dosage profile called Spread Out Bragg Peak (SOBP), a state where the radiotherapy dose is high and smooth in the region of the tumor and lower in areas beyond the tumor. The drawback of the measurement based on these traditional codes is the change in the tumor tissue's thickness and structure that results in imprecise results during high-dose proton irradiation. Dynamic changes in surface composition and tumor configuration can be analyzed with the 2D/3D extension of the dynamic variant of the binary collision code SDTrimSP (Static and Dynamic Trim for Sequential and Parallel Computers), overcoming the downside of accessing the exact effects of the SOBP profile. Based on a schematic model of tissue from the skin to the thyroid gland, the measurement was carried out by calculating the energy and the number of protons in each proton ray. Compared to previous studies by other studies, this study's SOBP profile is flatter on the tumor area, meaning that the tumor tissue receives a standardized high dose while other normal tissues surrounding it receive healthy doses. The maximum dose obtained by healthy tissue closest to the tumor relative to the tumor tissue dose was 10 % lower from the SOBP profile produced. On average, a much smaller dosage is given to the region beyond tumor tissue, which is around 60 % compared to the dose of tumor tissue. The findings reveal that to cover the thyroid layer fully, the optimal proton energy interval is around 40 to 54 MeV, where the 14 mm thick thyroid gland is situated 11.2 mm below the skin level, and a significant proportion of accumulated energy is around 53.5 MeV and 78 % of the energy of the proton-rays.

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HBRA in the coastal Kerala in India and concerns on certain congenital malformations

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Keywords: NHBRA, Kerala, Malformations, Congenital

Abstract

There are specific regions in the world with Natural High Background Radiation Areas (NHBRA). This include Ramsar in Iran, Guarapari in Brazil, Yangjiang in China other than India. In India states such as Kerala, Tamil Nadu, Andhra Pradesh and Orissa have large populations with generations under extraordinary radiation fields. Geology, high external gamma radiation fields, population density, occupancy patterns, socio-economic factors and life styles characterize are the major factors scientists look for in the NHBRAs. In all these regions, children and women of reproductive period constitute the critical group of investigations. The coastal region of Kollam district in Kerala state, India is known to have high background radiation originating from thorium rich monazite sand found plenty in the coast. There are reports of increased frequency of chromosomal aberrations in the lymphocytes of exposed persons. At the same time carcinogenic effects are not yet proven. There are concerns on the congenital malformations due to high background radiation prevailing in the region. The present study is an attempt to find the correlation between the incidence of certain congenital malformations through a 1:3 matched case-control study. The results of the study will be discussed in detail.

Design and synthesis better catalysts for low temperature NO_X reduction

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Abstract

The emission of nitrogen oxides (NO_X) from industrial sources contributes significantly to atmospheric pollution and subsequent environmental damage. Among all recognized measures, NH_3-selective catalytic reduction (SCR) is the most widely applied industrial method of nitrogen oxides emission control for industrial scale applications. However, the resistance of commercial SCR catalysts to water vapour deactivation in low temperature applications must be improved. In this study, we designed and synthesised a new promising high efficiency mixed metal oxide (MnO_X/FeO_X) catalyst series with high water vapour resistance property. The optimised catalyst achieved above 90% NO conversion in over a 125-225 °C temperature window, which was maintained even in the presence of up to 5% v/v H_2O. It was found that doping with polytetrafluoroethylene (PTFE) up to 10% (w/w), the MnO_X/FeO_X catalyst exhibited remarkably high performance of up to 98% NO conversion in low temperatures, with improved water resistance up to 10% v/v H_2O while retaining high performance from 100 °C. The new synthesised MnO_X/FeO_X catalysts were characterised as a mixture of the α-Fe_2O_3, Fe_3O_4, Mn_3O_4, and $FeMnO_3$ phases, as well as a notable disordered or highly dispersed amorphous MnO_X fraction, which are believed beneficial for improving the catalytic activity at low temperatures. Details of synthesis and characterization of the new high-performance SCR catalysts will be presented.

Intramolecular hydrogen bonding impact on O1s XPS of salicylic acid stereoisomers and their digital structures*

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Abstract

Hydrogen bonding in molecules is not merely a valence event, it affects the deep core. Oxygen is an important hydrogen acceptor, and its oxygen core electron ionization binding energy in a molecule will respond to stereoisomers. The present study calculated the oxygen core 1s (O1s) x-ray photoelectron spectroscopy (XPS) spectra of selected salicylic acid (SA) conformers (Fig 1(a))) and valence photoelectron spectrum (PES) of seven stable SA conformers (Fig 1(b)). It is found that the positions of the three O1s XPS signals of SA are strongly influenced by the existence of intramolecular hydrogen bonding of the SA conformers. The O···H information can be described using the digital conformer structures (Backler 2019) determined by three rotational angles around C-O and C-C single bonds. When forming a $C=O_{(2)}\cdots H_p\text{-}O_{(3)}$ hydrogen bond, the SA conformer stabilises and the carboxylic acid oxygen $O_{(1)}$1s binding energy is greater than the phenol oxygen $O_{(3)}$1s. Three conformers, SA-A(000), SA-B(010) and SA-C(100) are in this group. For the other SA conformers, SA-D(111), SA-E(011) and SA-F(001) and SA-G(101) without such a $O\cdots H_p$ hydrogen bond, their O1s binding energy spectra exhibit three bands and $O_{(1)}1s<O_{(3)}1s$, which are similar to the O1s spectra of 3-hydroxybenzoic acid or 4-hydroxybenzoic acid (A. Hill 2019).

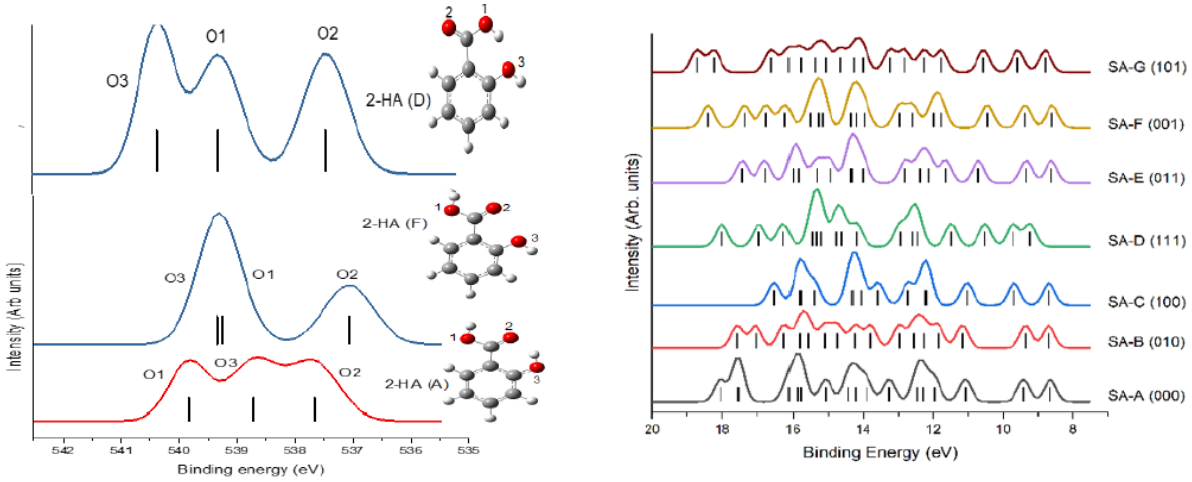

Fig. 1(a) Quantum mechanically calculated O1s XPS for SA-A(000), SA-D(111) and SA-F(001) conformers with large the H-bonding impact. (b) The calculated PES spectrum for all stable SA conformer.

Halogen impact on the UV-vis spectra of 4-Anilinoquinazoline tyrosine kinases inhibitors (TKIs)*

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Abstract

The epidermal growth factor receptor (EGFR) contributes to the growth of some lung cancers. Many available EGFR potent inhibitors such as AG-1478 and PD153035 share the same 4-anilinoquinazoline moiety (Fig 1). Bridges et al (Bridges 1996) discovered that the potency (IC50) of the inhibitors is largely dependent on the halogen on the (3-Xanilino) position. For example, this IC50 value for AG-1478 (X=Cl) is 0.31 nM whereas becomes 0.025 nM for PD153035 (X=Br). In the present study, we employ time-dependent density functional theory (TD-DFT) methods to study the halogen impact (X=H, F, Cl, Br and I) on properties such as conformational changes and their UV-Vis spectra of the 4-Anilinoquinazoline TKIs. The conformation and UV-vis spectra of AG-1478 have been previously studied both theoretically and experimentally with impressive results, (M. W. Khattab 2016) (M. C. Khattab 2016) which will serve as the method validation in the present study. Preliminary results will be present. UV-Vis absorption spectra in region of 290-306 nm of (TKIs) in DMSO solution have been calculated using (TD-DFT) methods for both global minima (planar) and lowest twisted energy (Bend) structures then for further comparison.

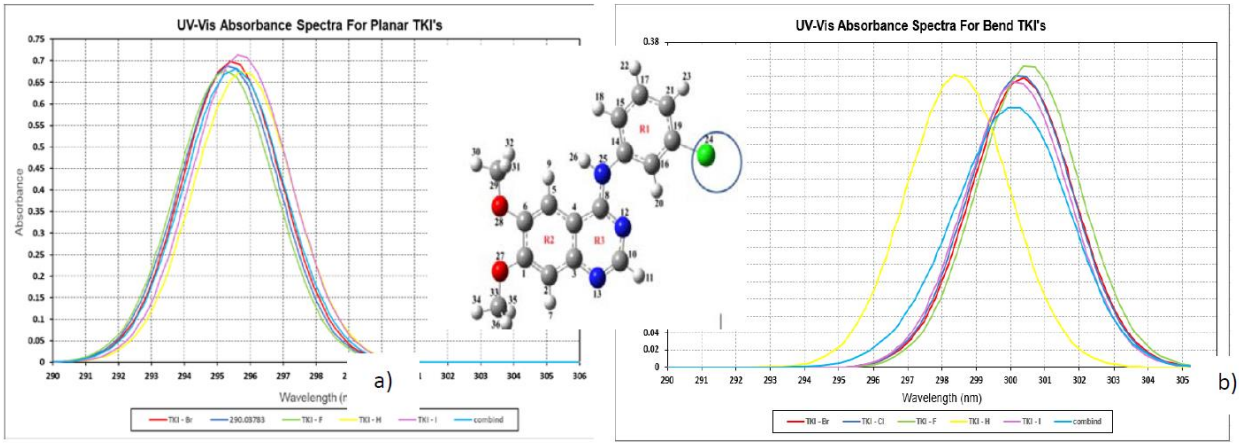

Fig. 1 Structure and nomenclature of the halogen derivatives (X=H, F, Cl, Br and I) of the 4-Anilinoquinazoline TKIs (insert). Simulated UV-vis spectra of the TKIs in planar (left) and twisted (right)conformation in DSMO solution, using TD-DFT calculations.

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