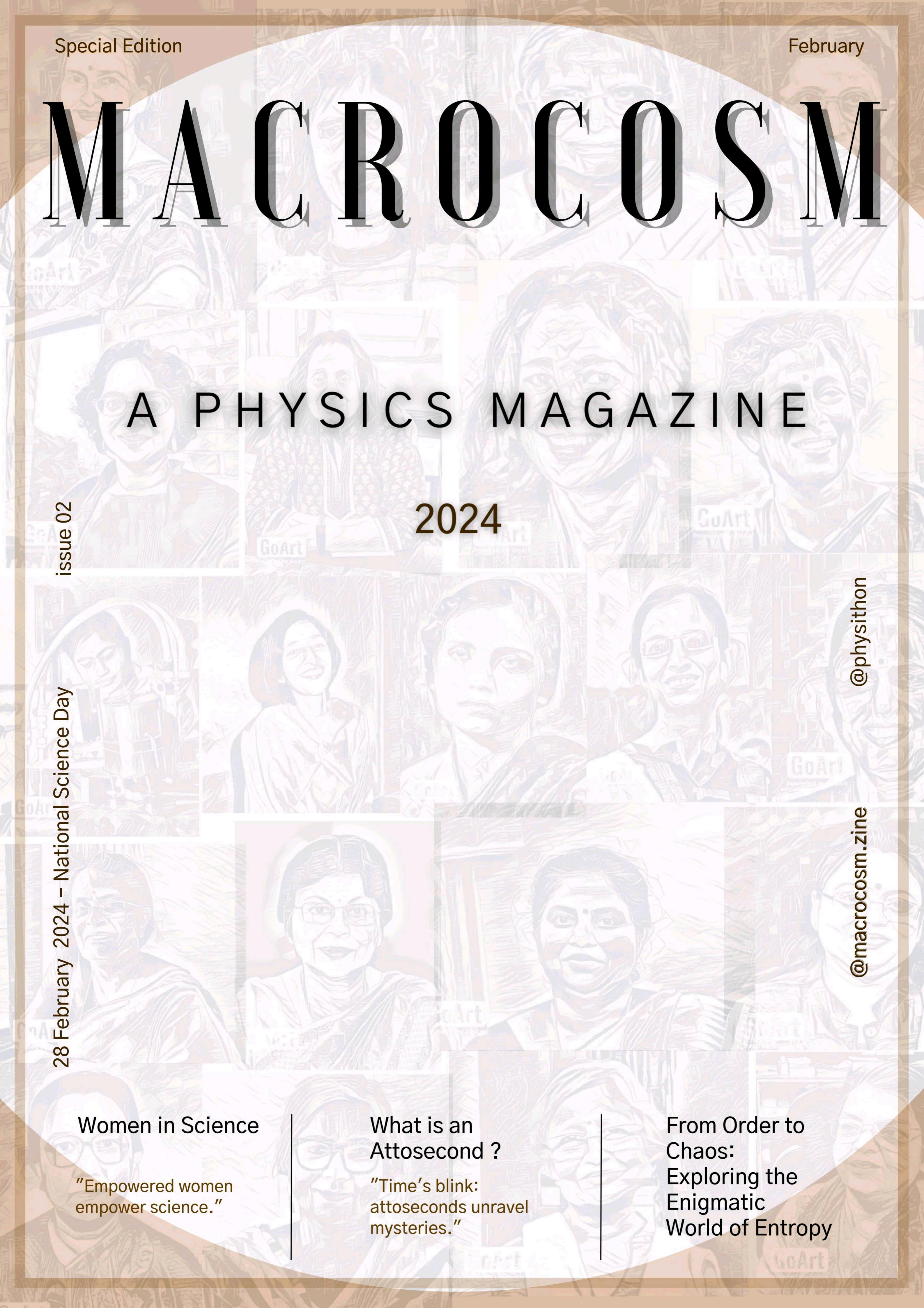

Special Edition

February

MACROCOSM

A PHYSICS MAGAZINE

2024

issue 02

28 February 2024 – National Science Day

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Women in Science

"Empowered women empower science."

What is an Attosecond ?

"Time's blink: attoseconds unravel mysteries."

From Order to Chaos: Exploring the Enigmatic World of Entropy

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FROM THE STUDENT EDITOR

Dear Readers,

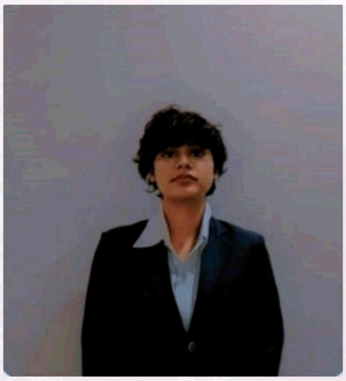
Welcome to the second edition of our Physics Magazine, a special issue dedicated to the remarkable contributions of women in the field of physics and mathematics. As the Chief Student Editor, it is with great enthusiasm that I present to you a collection of articles that not only showcases the groundbreaking research conducted by women but also pays tribute to their resilience, intellect, and passion for pushing the boundaries of knowledge.

In our magazine, we delve into the lives and achievements of trailblazing women who have made significant strides in various branches of physics and mathematics. From historical figures who defied societal norms to contemporary researchers shaping the future, these stories highlight the indispensable role women play in advancing our understanding of the universe.

We invite you to immerse yourself in this special edition, as we recognize and applaud the women who continue to inspire and revolutionise the world of Science. We hope that their stories ignite a spark of curiosity and determination in each reader, fostering an environment where all individuals, regardless of gender, feel empowered to contribute to the ever-expanding realm of scientific discovery.

Thank you for joining us in celebrating Women in Research. Together, let us continue to champion diversity and progress in the world of physics.

Sincerely,



Varsha Sharma
Chief Student Editor

FROM THE TEACHER EDITOR

Dear Readers,
Welcome to a special issue of Macrocosm, one that resonates with the vibrant energy of discovery and the enduring power of diverse perspectives. This edition focuses on the legendary contributions of women physicists and mathematicians in their fields and how we can learn and get inspired from their journey.

From groundbreaking theoretical frameworks to meticulous experimental work, the articles within these pages highlight the remarkable impact of women in fields traditionally dominated by men. We explore their challenges, their triumphs, and the enduring legacy they leave for future generations. It is a reminder that scientific excellence knows no gender, and that true progress is achieved when we embrace the full spectrum of human talent.

We are particularly thrilled to feature an insightful interview with Dr. Sayan Saha, a young physicist whose passion for unraveling the mysteries of the cosmos is both inspiring and illuminating. Sayan's fresh perspective and dedication to his field remind us that the future of scientific exploration rests in the hands of bright, driven individuals who dare to ask the big questions.

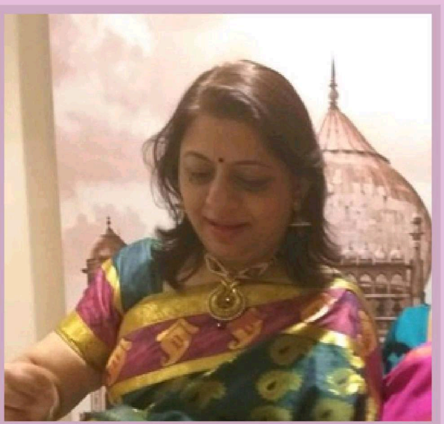
Beyond the featured interview and the focus on women in physics, you'll find our usual array of thought-provoking articles and editorials, each designed to ignite your curiosity and expand your understanding of the cosmos. We delve into cutting-edge research, explore emerging theories, and ponder the philosophical implications of our ever-evolving knowledge.
This issue of Macrocosm is more than just a collection of articles; it is a celebration of the collaborative spirit of science, a recognition of the power of diverse voices. We hope you find it as enlightening and inspiring as we do.

Thank you for joining us on this journey of discovery.

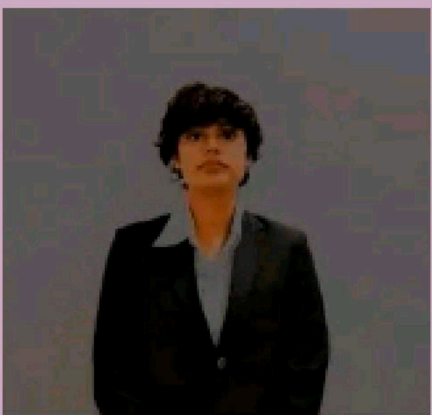
Sincerely,

Punita Verma
Teacher Editor, Macrocosm

MEET THE TEAM



PROF. PUNITA VERMA
CHIEF TEACHER
EDITOR



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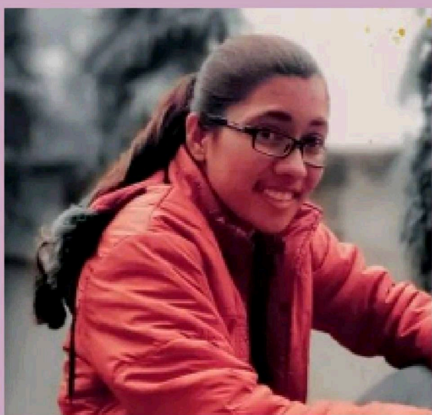
CHIEF EDITOR



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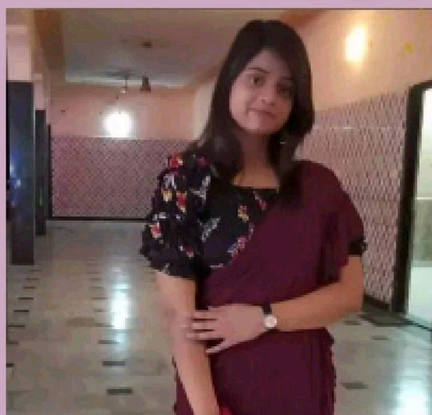

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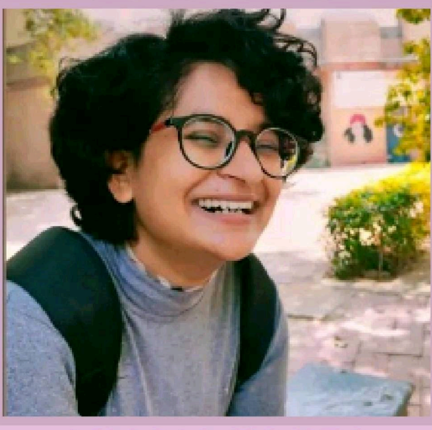

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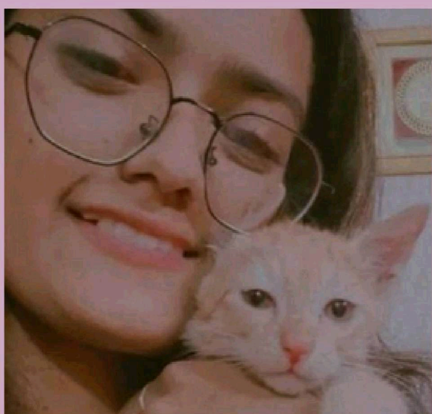

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MOUSUMI DAS
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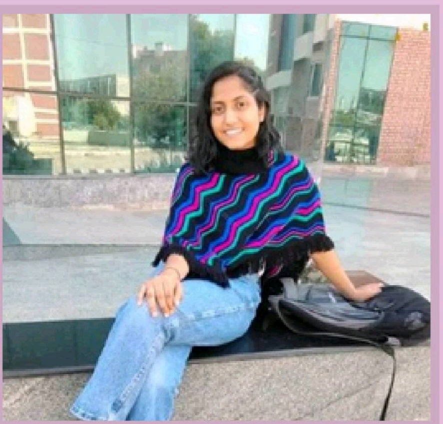
MANAGER



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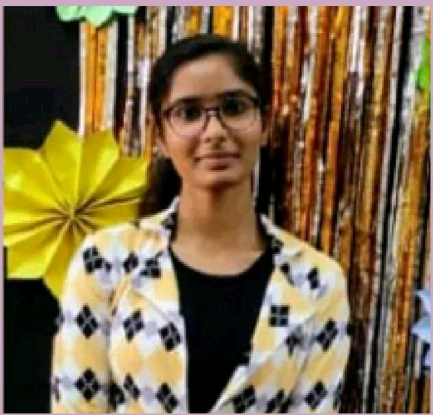

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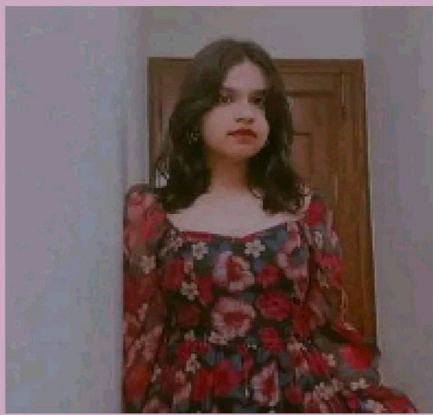

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SURUCHI SINGH
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MADHAVI SHARMA
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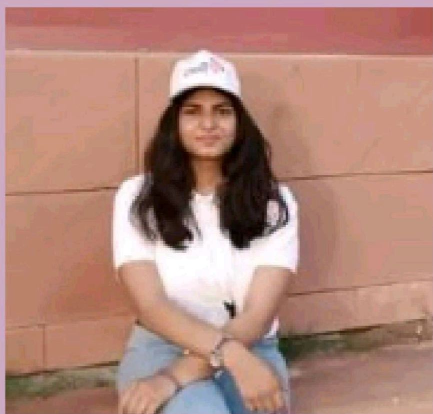

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CHHAVI JHAWAR
GRAMMAR CHECKER

SIDDHI SRIVASTAVA
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Ajit Iqbal Singh

Introduction*:*
Ajit Iqbal Singh (born 1943) is an Indian mathematician, specializing in functional analysis and harmonic analysis. Singh is a Fellow, India's apex body of scientists and technologists. She is also a fellow of the National Academy of Sciences (India), based in Allahabad.

- **Address:** *Apartment No.102, 6th floor, Block 2, Din Apartments, Plot No.7, Sector 4, Dwarka, New Delhi*
- **Email Address:** *ajitis@gmail.com*
- **Research Group:** *Functional Analysis, Harmonic Analysis, Quantum Information Theory*
- **Designation:** *Honorary Scientist*
- **Institution:***.Indian National Science Academy (INSA)*

Education:
BA Hons (Mathematics) in 1963 from Indrapastha College, University of Delhi, MA (Mathematics) in 1965, from Delhi University, PhD from University of Cambridge as a Commonwealth Scholar in 1969 under the supervision of F Smithies

Area of Research: *Areas of linear operators in locally convex spaces, locally convex algebras, spectral synthesis on hypergroups, applications of harmonic analysis to differential equations and orthogonal polynomials, geometry of the range of a vector measure, quotient rings of algebras of functions and operators, involutions in Banach algebras related to group algebras and quantum entanglement.*

Publication:
Recent developments on Arens regularity and ideal structure of the second dual of a group algebra and some related topological algebras, Entanglement properties of positive operators with ranges in completely entangled subspaces

Awards/Achievements:
Rai Bahadur Brij Mohan Lal Saheb Memorial Gold Medal, Ravi Kanta Devi Prize of the University of Delhi, Fellow of the National Academy of Sciences (India), Allahabad, Fellow of the Indian National Science Academy (INSA).

Contemporary Mathematician

Raman Parimala

Introduction : *RAMAN PARIMALA (born 21 November 1948) is an Indian mathematician known for her contributions to algebra. She is the Arts & Sciences Distinguished Professor of mathematics at Emory University. She has been on the Mathematical Sciences jury for the Infosys Prize from 2019 and is on the Abel prize selection Committee 2021/2022.*

- **Address Office:** *W420*
- **Phone: 404-727-7577**
- **Email:** *parimala.raman@emory.edu*
- **Personal Website:** *http://www.math.emory.edu/~parimala*
- **Research Groups:** *Algebra and Number Theory*
- **Designation:** *professor*
- **Institution:** *Emory University*

Education:
She studied in Saradha Vidyalaya Girls' High School and Stella Maris College at Chennai. She received her M.Sc. from Madras University (1970) and Ph.D. from the University of Mumbai (1976).

Area of research:
Parimala works in algebra. Her research uses tools from number theory, algebraic geometry, and topology.

Publication:
Failure of a quadratic analogue of Serre's conjecture, Quadratic spaces over polynomial extensions of regular rings of dimension 2,

Awards or achievements:
Fellow of the Indian Academy of Sciences, Fellow of Indian National Science Academy, Shanti Swarup Bhatnagar Award (1987), Honorary doctorate from the University of Lausanne in 1999, Srinivasa Ramanujan Birth Centenary Award in 2003., TWAS Prize for Mathematics (2005)., Fellow of the American Mathematical Society (2012)

Raman Parimala has been described as a "supreme and powerful algebraist". Early in her career, she published the first example of a nontrivial quadratic space over an affine plane. This result surprised many experts and has since led to further developments in the field.

Neena Gupta

Education: *BSc (Honours) in Mathematics from Bethune College, Post Graduation in Mathematics from Indian Statistical Institute, PhD in Commutative Algebra from Indian Statistical Institute*

Research-Area:-*Mathematics, commutative algebra, affine algebraic geometry*

Publications: *On the cancellation problem for the affine space in characteristic p, On Zariski's cancellation problem in positive characteristic, On the family of affine threefolds, A survey on Zariski cancellation problem, The epimorphism theorem and its generalizations*

Awards and Achievements:
Saraswathi Cowsik Medal by the TIFR Swarna Jayanti Fellowship Award, TWAS Young Affiliates, DST-ICTP-IMU Ramanujan Prize for Young Mathematicians from Developing Countries , Fellow of the Indian Academy of Sciences, Nari Shakti Puraskar , Fellow of the Indian National Science Academy.

Social Impact of the work:
She made history by being the first person to solve the world's most significant math problem, "The Zariski cancellation problem", proposed by Oscar Zariski in 1949 and unsolved for as much as 70 years.

Introduction:
Neena Gupta (born in 1984) is a professor at the Statistics and Mathematics Unit of the Indian Statistical Institute (ISI), Kolkata. Her primary fields of interest are commutative algebra and affine algebraic geometry.

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Email:*neenag@isical.ac.in*
Institution: *Indian Statistical Institute*
Designation: *Professor*

Sujatha Ramdorai

Introduction:
Professor Sujatha Ramdorai (born 1962) is a mathematician renowned for her contributions to the Iwasawa theory. She currently holds the Canada Research Chair in the Department of Mathematics at the University of British Columbia in Canada.

Address: *Mathematics Department, 1984, Mathematics Road, University of British Columbia, Vancouver, V6T1Z2 Canada.*
Office: *Math Annex 1201*
Contact: *+1-604-822-3627*
Email ID: *sujatha /at/ math.ubc.ca*
Website:
https://personal.math.ubc.ca/~sujatha/
Research Interests: *Algebraic theory of quadratic forms, Non-commutative Iwasawa theory, Study of motives.*
Designation: *Professor*
Institute: *University of British Columbia*

Education:
B.Sc. in 1982 from St. Joseph's college, Bangalore., M.Sc. through correspondence from Annamalai University in 1985., PhD at Tata Institute of Fundamental Research under supervision of Raman Parimala in 1992.

Areas of Research:
Interests: *Algebraic theory of quadratic forms, Arithmetic geometry of elliptic curves, Non-commutative version of the main conjecture of Iwasawa theory.*

Publications:
The GL2 main conjecture for elliptical curves without complex multiplication, Root numbers, Selmer groups, and non-commutative Iwasawa theory, Modules over Iwasawa algebras, Computations in non-commutative Iwasawa Theory.

Awards and Achievements:
First Indian to win the ICTP Ramanujan Prize in 2006, Shanti Swarup Bhatnagar Award in 2004, Recipient of 2020 Krieger–Nelson Prize, Padma Shri award by the Government of India for 2023.

Shakuntala Devi

Publication*:*
Perfect Murder. New Delhi: Orient Paperbacks. 1976. OCLC 3432320.
Puzzles to Puzzle You. Delhi: Orient Paperbacks. 1976. ISBN 978-81-222-0014-0. OCLC 881704076.
The World of Homosexuals. New Delhi: Vikas Pub. House. 1977. ISBN 978-0-7069-0478-9. OCLC 3554716.
More Puzzles to Puzzle You. New Delhi: Orient Paperbacks. 2004. ISBN 978-81-222-0048-5. OCLC 1194441931 – via Internet Archive.
Astrology for You. New Delhi: Orient Paperbacks. 2005. ISBN 978-81-222-0067-6. OCLC 698472904.

Awards/Achievements:
The authenticity of Shakuntala Devi's talents gained her many awards and achievements. One of the well-known titles that capped her talent is "Human-Computer." She outperformed the most sophisticated computers at the time and mesmerized people with her mathematical capabilities.
In 1980, Devi's successful attempt to multiply two random 13-digits in 28 seconds was recorded for the year 1982 of The Guinness Book of World Records.

Introduction*: Shakuntala Devi (4 November 1929 – 21 April 2013) was an Indian mental calculator and writer, popularly known as the "Human Computer".*

Her talent earned her a place in the 1982 edition of The Guinness Book of World Records. However, the certificate for the record was given posthumously on 30 July 2020, despite Devi achieving her world record on 18 June 1980 at Imperial College, London.

Devi was a precocious child and she demonstrated her arithmetic abilities at the University of Mysore without any formal education.

Urmila Balawant Apte

Introduction:
Urmila Balavant Apte is the Indian Founder of the Bharatiya Stree Shakti organization in 1988 which is dedicated to the empowerment of women. She received the Nari Shakti Puraskar from President Ram Nath Kovind in 2018 for her work. Apte is a mathematician who gained a master's degree from the University of Mumbai in mathematics. In 1969 she used her teaching qualification and master's degree to teach math at various colleges in Mumbai.

- **Website**: *https://www.bharatiyastreeshakti.org/smt-urmila-apte/*
- **Designation**: *President, Bharatiya Stree Shakti*

Education:
M.Sc.(Mathematics), University of Mumbai, Diploma in Higher Education.

Awards/Achievements:
- *Nari Shakti Puraskar – 2017, Ministry of Women and Child Development, Govt. India.*
- *Stree Shakti Puraskar-2010, Brihan Mumbai Mahanagar Palika, Mumbai*
- *Ojaswani Alankaran – 2008 at Bhopal (M.P.)*

Social Impact: *Ongoing Activities: Health camps for women, Family Counseling, Awareness programmes for women regarding Laws, Health,Self Employment, Marketing Process, Self-help groups etc., VachakManch (reader's forum) – A monthly literacy activity for women, Family life, education programmes for adolescent girls in urban and rural areas.*
- *2000 | Competition and networking of MahilaMandals in Mumbai region*
- *1996 | Awareness programmes against propagation of extreme permissiveness, violence and vulgarity through media*
- *1995 | Pre-marital counseling camps for youth*
- *1990 | Vocational guidance programmes for girls and women*

Contemporary Mathematician

Bhama Srinivasan

Education:
She attended the University of Madras, earned her B.A. degree in 1954 and her M.Sc. degree in 1955. She traveled to England for her doctoral study. She pursued a postdoctoral fellowship at the University of British Columbia through the National research Council of Canada from 1965 through 1966.She returned home to India to teach at the Ramanujan Institute of Mathematics of her Alma mater, the University of Madras, from 1966 though 1970.

Area of Research:
Representation Theory of Finite Groups

Publication:
Srinivasan, Bhama (1968), "The characters of the finite symplectic group Sp(4,q)", Srinivasan, Bhama (1979), Representations of finite Chevalley groups., Fong, Paul; Srinivasan, Bhama (1982)

Awards/Achievements:
In 2012 she became a fellow of the American Mathematical Society.[4] In 2017, she was selected as a fellow of the Association for Women in Mathematics in the inaugural class. She is included in a deck of playing cards featuring notable women mathematicians published by the Association of Women in Mathematics

Introduction:
Bhama Srinivasan (born 22 April 1935[1]) is a mathematician known for her work in the representation theory of finite groups. Her contributions were honored with the 1990 Noether Lecture. She served as president of the Association for Women in Mathematics from 1981 to 1983.

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Decedent Mathematician

Mangala Narlikar

Introduction:
Mangala Narlikar (17 May 1943 – 17 July 2023) was an Indian mathematician who did research in pure mathematics as well as writing for a lay audience. After her degrees in mathematics, she initially worked at the Tata Institute of Fundamental Research (TIFR) in Mumbai and later worked as a lecturer in the University of Bombay and Pune.

Education &Work:

- *B.A. (Maths), 1962, University of Bombay*
- *M.A. (Maths), 1964 & won Chancellor's Gold Medal*
- *Doctoral Degree, 1981*
- *Worked at TIFR 1982-1985 Pool Office in the School of Mathematics*
- *1967-69 -Taught Undergraduate school at the University of Cambridge*

Area of Research:
Analytic Number Theory, real and complex analysis, analytic geometry, number theory, algebra, and topology.

Publication:
Narlikar published a number of scientific papers and books which included:

Papers

- *Theory of Sieved Integers, Acta Arithmetica 38, 157 in 19*
- *On a theorem of Erdos and Szemeredi, Hardy Ramanujan Journal 3, 41, in 1980*
- *On the Mean Square Value theorem of Hurwitz Zeta function, Proceedings of Indian Academy of Sciences 90, 195, 1981.*
- *Hybrid mean Value Theorem of L-functions, Hardy Ramanujan Journal 9, 11 - 16, 1986.*

Books

- *Ganitachyaa Sopya Vata, a book in Marathi for schoolchildren*
- *An Easy Access to Basic Mathematics, a book for schoolchildren.*
- *A Cosmic Adventure, translation of a book on Astronomy by Professor J. V. Narlikar.*

Awards/Achievements: *She won Suryadatta Life Time Achievement Award 2017 for Excellence in the field of Science and Technology.*

Vanaja Iyengar

Introduction:
Vanaja Iyengar (died 2001) was an Indian mathematician, educationist and the founder vice-chancellor of Sri Padmavati Mahila Visvavidyalayam, Tirupati, in the south Indian state of Andhra Pradesh.She was one of the founders of the Andhra Mahila Sabha School of Informatics.The Government of India awarded her the fourth highest civilian honor of Padma Shri in 1987.

Education & Work:

- *higher education in Mathematics from Cambridge University in 1950*
- *doctoral degree in mathematics from the University of Delhi in 1958*
- *served Osmania University as a reader, professor, head of the department of Mathematics department and the principal of the University College for Women, Koti*
- *Sri Padmavati Mahila Visvavidyalayam, an all women university, was established in 1983, she was appointed as its vice-chancellor and continued at the post till 1986*

Awards/Achievements: *In 1987, the Government of India awarded Iyengar the civilian honour of Padma Shri. She received the Best Teacher award from the Government of Andhra Pradesh and was a fellow of the Rajiv Gandhi Foundation. She died in 2001, survived by her husband, Mohit Sen, a known communist intellectual, who also died two years later.*

Decedent Mathematician

Indulata L. Sukla

Introduction:
Indulata L. Sukla (7 March 1944 – 30 June 2022)[1] was an Indian academic, who was professor of mathematics for more than three decades at Sambalpur University, Sambalpur, Odisha.

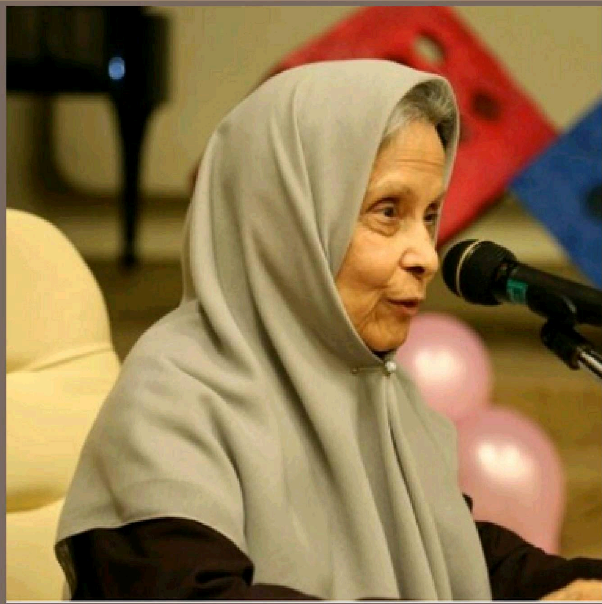
Education:
Schooling: Maharani Prem Kumari Girls' School
B.Sc. with Mathematics Honours: M.P.C. College, Baripada
M.Sc. in Mathematics: Ravenshaw College, Cuttack (1966)
Career:
Lecturer: M.P.C. College (brief stint)
Pursued Ph.D.: University of Jabalpur with a CSIR Fellowship under the supervision of Tribikram Pati
Joined Sambalpur University: November 1970 as a lecturer in the School of Mathematical Sciences
Retirement: March 2004

Publication:
- Authored the textbook "Number Theory and Its Applications to Cryptography" published by Kalyani Publishers in 2000.
- Collaborated with English mathematician Brian Kuttner on Fourier Series research.
- Holds life membership in both the American Mathematical Society (AMS) and the Indian Mathematical Society (IMS).

Awards/Achievements:

- *- **Recipient of Lifetime Achievement Award**: The Orissa Mathematical Society (OMS) honored her for her significant contributions in Number Theory, Cryptography, and Analysis.*
- *- **Presenter of the Award**: Professor Ramachandran Balasubramanian, Director of the Institute of Mathematical Sciences, Chennai, presented her with the award.*
- *- **Venue and Event**: The award ceremony took place at the 42nd Annual Conference of OMS, hosted at Vyasanagar Autonomous College, Jajpur Road, Orissa.*
- *- **Date of the Ceremony**: The recognition occurred on February 7, 2015.*

Mahbanoo Tata



Introduction:

Mahbanoo Tata (26 April 1942 – 7 August 2023) was an Indian-born Iranian statistician. She was widely regarded as the founder of statistics in Iran.

Education:

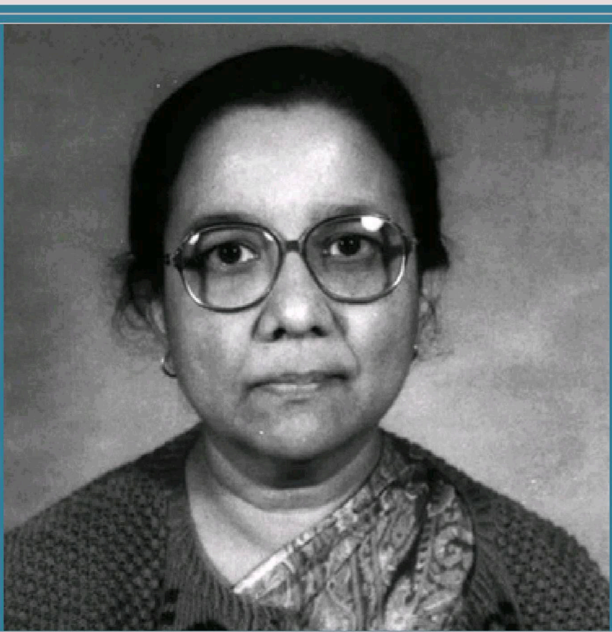
1. Mahbanoo Tata was a Zoroastrian (Parsi) from Bombay.
2. She attended her local university to obtain her bachelor's and master's degrees.
3. Later, she attended Purdue University and earned a Ph.D. in statistics in 1967.
4. After completing her education, Mahbanoo Tata pursued a career in academia.
5. She became a professor of statistics and worked at several universities in Iran.

Publication:

She has authored or co-authored five publications, covering various aspects of statistics, probability theory, and applied mathematics.

- *"Asymptotic Behavior of Eigenvalues of Variance-Covariance Matrix of a High-Dimensional Heavy-Tailed Lévy Process": Investigates the behavior of eigenvalues of the variance-covariance matrix of a random sample from a multivariate subordinator heavy-tailed Lévy process.*
- *"Comparison of aggregation, minimum and maximum of two risky portfolios with dependent claims": Explores the comparison of two risky portfolios with dependent claims, relevant in insurance and finance.*
- *"Shannon Information In k-records": Discusses the Shannon information contained in upper and lower k-record values and associated k-record times.*
- *"Shannon information in record data": Presents results on the Shannon information contained in upper and lower record values and associated record times in a sequence of i.i.d continuous variables.*
- *"The Rényi information in record data from an inverse sampling plan": Examines the Rényi information contained in upper and lower record values and associated record times in a sequence of i.i.d continuous variables using an inverse sampling plan.*

Indrani Bose



Introduction : *Indrani Bose, born on August 15, 1951, is an esteemed Indian physicist and senior Professor at the Department of Physics, Bose Institute in Kolkata. Bose's research interests include the problem of quantum many body systems, quantum information theory, statistical mechanics and systems biology.*

Address : *NASI Honorary Scientist, Department of Physics, Bose Institute, 93/1, APC Road Kolkata 700 009, W.B.*

Contact Number : *(033) 2303 1184*
E-mail ID : *ibose1951@gmail.com*
Institution : *Physics Department, Bose Institute, Calcutta*
Designation : *Emeritus Scientist*

Education : *Ph.D. in Physics from Rajabazar Science College, University of Calcutta, in 1981*
Area of Research : *Theoretical condensed matter, quantum information theory, statistical physics, biological physics and systems*

Work : *She is a fellow of the Indian Academy of Sciences, Bangalore[3] and of the National Academy of Sciences, Allahabad.*

She also developed a strong solid-state theory group in the Bose Institute , devoted to the study of magnetism, strongly correlated systems and exactly soluble quantum models.

Awards & Achievements :

- *first recipient of the Stree Shakthi Science Samman award (2000) for her work on exact solutions of model Hamiltonian (low dimensions) in the context of magnetic systems.*

Shobhana Narasimhan

Education : *Shobhana Narasimhan obtained her MSc from IIT Bombay (where she was the Institute Silver Medallist), and an MA and PhD from Harvard University.*

Area of Research : *Computational Nnaoscience*

Publications : *Saptarshi Chakraborty, Gauttam Dash, Subhashri Mannar, Krishna Maurya, Arpan Das, Shobhana Narasimhan, Bivas Saha, Ranjani Viswanatha, "Non-Resonant Exciton-Plasmon Interaction in Metal-Chalcogenide CuxS/Perovskite (CsPbBr3) Based Colloidal Heterostructure", The Journal of Physical Chemistry C, 127, 31, 15353-15362 (2023).*

Awards & Achievements :

- *She did postdoctoral work at Brookhaven National Laboratory, USA, and the Fritz Haber Institut, Berlin, Germany.*
- *Currently also an Anna Boyksen Fellow at the Institute for Advanced Study, Technical University Munich, Germany. She has been elected as an International Honorary Member to the American Academy of Arts and Science.*
- *She was named a fellow of the American Physical Society.*

Introduction : *Shobhana Narasimhan was named a Fellow of the American Physical Society in 2022 "for significant contributions to promoting diversity, combating discrimination in the physics community, and conceiving and organizing Career Development Workshops for Women in Physics that have had a transformative effect on the trajectories of female physicists".*

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Contact Number : *+91 8022082833*

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Institution : *Jawaharlal Nehru Centre for Advanced Scientific Research*
Designation : *Professor*

Amrita Das

Introduction : *Amita Das (born 3 August 1965) is an Indian plasma physicist. Her research interests are in laser-plasma interactions, nonlinear plasmas, plasma turbulence and the properties of strongly coupled and dusty plasma systems.*

Address : *Department of Physics, Main Building MS 410*
Contact Number : *011 2654 8701*
E-mail ID : *amita@iitd.ac.in*
Institution : *Indian Institute of Technology Delhi*
Hauz Khas New Delhi - 110016
Designation : *Professor*
Education :

- *B.Sc. from Patna University*
- *M.Sc. from IIT, Kanpur*
- *Ph.D. from IIT, Kanout*

Area of Research :

- *Nonlinear and turbulent phenomena in laboratory, astrophysical and fusion plasmas.*
- *Laser Plasma interaction: Applications - medical, security etc., fundamental issues - QED and radiation reaction effects in collective plasma environment.*
- *Dusty plasmas as strongly coupled state of matter, interdisciplinary connections with condensed matter, visco-elastic fluid systems, behaviour of active matter.*
- *Numerical Simulation of Plasma Phenomena: Fluid, Molecular Dynamics and Particle - In - Cell.*

Publications :

- *Localized absorption of laser energy in X-mode configuration of magnetized plasma*
- *Plasma Fusion and Controlled Nuclear Fusion, 65:035006, (2023).*

Awards & Achievements :

- *J.C. Bose Fellowship (2019) -DST*
- *Fellow of Indian Natinal Science Academy India (2019) -INSA*
- *Women Excellence Award (Scientist & Innovator(- Utkarsh Foundation India (2015)*

Radha Balakrishnan

Research Area:

- *Nonlinear Dynamics and applications to various physical systems .*
- *Geometric phases associated with nonlinear systems mappable to space curves, e.g., classical spin chains, twisted optical fibers, phase space trajectories.*
- *Connections between nonlinearity and geometry in classical integrable systems.*
- *Topological solitons and their knotted structure in 3D classical magnetic systems.*

Publications:

- *Exact Hopfion vortices in a 3D Heisenberg ferromagnet. Radha Balakrishnan, R. Dandoloff and A. Saxena, Phys. Lett. A 480, 128975 (2023).*
- *Twisted curve geometry underlying topological invariants. Radha Balakrishnan, R. Dandoloff and A. Saxena, Phys. Lett A 493, 129261 (2024).*

Awards and achievements:

- *Professor Darshan Ranganathan Memorial Lecture Award (2005) from the Indian National Science Academy (INSA), for original and pioneering contributions in Nonlinear Dynamics.*

Address : *RSA Annex*
Contact Number : *011 22543177*

E-mail ID : *radha@imsc.res.in*
Institution: *The Institute of Mathematical Sciences*
Designation: *Retired Professor, Theoretical Physics*

Education:
B.Sc (Hons) Physics, University of Delhi, Delhi , India (1963)
M. Sc Physics, University of Delhi, Delhi, India (1965)
M.S (Theoretical Physics), University of Rochester, Rochester N.Y. ,USA (1967)
Ph. D, Brandeis University, Waltham MA, USA (1970)

Rohini Godbole

Introduction :*Rohini Godbole is an Indian physicist and academic specializing in elementary particle physics: field theory and phenomenology.[7] She is currently a professor at the Centre for High Energy Physics, Indian Institute of Science, Bangalore.[8] She has worked extensively on different aspects of particle phenomenology over the past three decades, in particular on exploring different aspects of the Standard Model of Particle Physics (SM) and the physics beyond it (BSM).s*

Institution : *Indian Institute of Sciences*
Designation : *Physicist/Professor*

Education : *IIT Bombay*
State University of New York, Stony Brook

Area of Research : *Godbole has been working in the following areas-[15]*

- *New Particle Production at current and future colliders*
- *Physics at Large Hadron Collider and Next Linear Collider*
- *QCD phenomenology: Structure Functions of a proton, photon and nucleus*
- *Supersymmetry and Electroweak Physics*

Publications : *She is the author of more than 150 research papers; many of which have some of the largest citation indices in her area*

- **Awards & Achievements** : *Honorary doctorate, IIT Kanpur (2021).*
- *Padma Shri for her contributions in science and technology (2019).*
- *Satyendranath Bose Medal of Indian National Science Academy (2009)*
- *Fellowship of National Academy of Sciences, India (NASI) (2007)*
- *Fellowship of Academy of Sciences of the Developing World, TWAS 2009*
- *Devi Award of the New Indian Express Group, August 2015.[*
- *Ordre National du Mérite by the French government*

Archana Bhattacharyya

Introduction : *Archana Bhattacharyya (born 1948) is an Indian physicist. She specializes in the field of ionospheric physics, geomagnetism, and space weather and is Director of the Indian Institute of Geomagnetism, Navi Mumbai*

Area of Research :
Plasma instabilities in the equatorial ionosphere

- *Probing the ionosphere with radio waves*
- *Effects of space weather on the ionosphere*
- *Spatio-temporal variations of the geomagnetic field*

Designation : *Physicist*

Education : *Bhattacharyya completed B.Sc. (Hons) and M.Sc. in physics from the University of Delhi in 1967 and 1969, respectively. She also held a National Science Talent Scholarship (1964–69). She received PhD degree in physics from Northwestern University (1975)*

Awards & Achievements : *The Professor KR Ramanathan Memorial Lecture and Medal by the Indian Geophysical Union in 2008*

- *Dr. KS Krishnan Gold Medal by the University of Delhi in 1969*
- *Fellow of the Indian Academy of Sciences and National Academy of Sciences, India.[2]*

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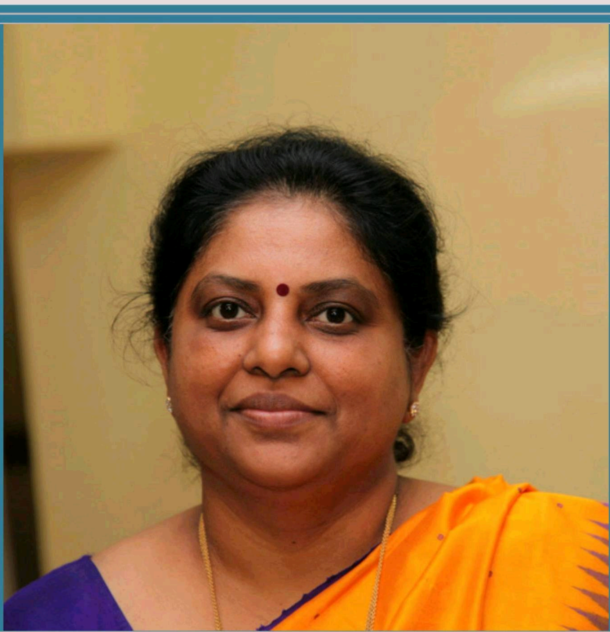
Tessy Thomas



Introduction : *Tessy Thomas was born in April 1963 in Thathampally of Kerala. Growing up in a modest family, Dr. Tessy Thomas developed a fascination for science and technology from a young age. Growing up near the Thumba Equatorial Rocket Launching Stations attracted towards the rockets and missiles.*

Address:

Institution : *DRDO*

Designation: *Scientist*

Education : *Dr Tessy Thomas did B.Tech in Electrical Engineering in 1983 from the University Of Calicut and then pursued DRDO-sponsored ME in Guided Missiles from the Institute of Armament Technology. She also did PhD in Missile Guidance from Jawaharlal Nehru Technological University (JNTU), Hyderabad in 2014. She obtained MBA in Operations Management from Indira Gandhi National Open University (IGNOU), New Delhi, in 2007.*

Area of Research : *Agni, Agni 3, Agni 5*

Awards & Achievements : *sas Lal Bahadur Shastri National Award Lokmanya Tilak National Dr Thomas Cangan Leadership Award Award Woman pioneer of the year'*

Ritu Karidhal

Introduction : *Ritu Karidhal Srivastava is a distinguished scientist and aerospace engineer who has become synonymous with India's ambitious space program. Nicknamed the "Rocket Woman of India," Karidhal has played a pivotal role in several successful space missions, including: Chandrayaan 2, Chandrayaan 3 and Mangalyaan*

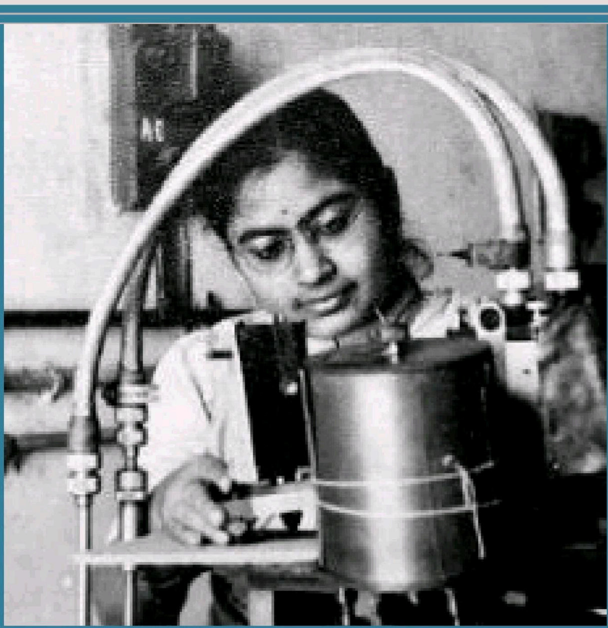
Address : *Bengaluru,Karnataka , India*

Career :

Ritu Karidhal has worked for ISRO since 1997.[4] She played a key role in the development of India's Mars Orbiter Mission, Mangalyaan, dealing with the detailing and the execution of the craft's onward autonomy system. She ha splayed crucial roles in India's Mission to Moon- Chandrayaan 2 and Chandrayaan 3.

Education :
University of Lucknow
Indian Institute of Science
Born:
13 April 1975
Lucknow, Uttar Pradesh, India
Occupation : *Scientist*
Awards & Achievements : *ISRO Young Scientist Award*

Lilabhati Bhattacharjee



Introduction : *Lilabati Bhattacharjee (née Ray) was a mineralogist, crystallographer and a physicist. She studied with the scientist Satyendra Nath Bose*

Education : *Completed her MSc in physics from the University College of Science and Technology (commonly known as Rajabazar Science College), University of Calcutta in 1951.*

Area of Research : *Structural crystallography, optical transform methods, computer programming, phase transformations, crystal growth, topography, and instrumentation.*

Awards & Achievements :
She served as a Senior Mineralogist at the Geological Survey of India, and later went on to become its Director (Mineral Physics).

B. Vijayalakshmi

Area of Research : *Relativistic Equations of higher soin in external electromagnetic & gravitational fields, looking for ways higher spin theories could be constructed.*

Career & Life : *It was during her studies in quantum mechanics that she was diagnosed with widespread stomach and abdominal cancer, eventually keeping her to a wheelchair, but persisted with her work.*
She died on 12 May, 1985.

Sashi Kumar created a documentary about her life called "Vijayalakshmi: The Story of a Young Woman with Cancer"

Soon after she worked on spinning particle in non-relativistic quantum mechanics. It was around 1978 when the Association of Research Scholars of the Madras University was formed and was contributed to by B. Vijayalakshmi. In 1980 she gave talks at the biannual High Energy Physics Symposium of the Department of Atomic Energy held at the university in Kochi.

Introduction : *Vijayalakshmi, also known as Viji, was born in 1952 in a conservative family. She overcame gender restrictions and pursued excellence in education and her field of Physics all her life.*

Education : *After completing her Masters from Seethalakshmi Ramaswami College, Tiruchirapalli, she joined the Department of Theoretical Physics to obtain her PhD from Madras University in 1974*

During her PhD studies, Vijayalakshmi found out she had stomach cancer.

Bibha Chowdhuri

Introduction : *Bibha Chowdhuri was an Indian Physicicst. Working with D M Bose, she was the first to use the photographic nuclear emulsion method to detect and identify cosmic ray muons. The IAU has re-christened the star HD 86081 as Bibha (a yellow-white dwarf star in the constellation Sextans south of the celestial equator) after her.*

Education : *Bibha studied physics at Rajabazar Science College of Calcutta University and was the only woman to complete M.Sc. degree in the year 1936.*

She studied batches of Ilford half-tone plates that were exposed to cosmic rays at different altitudes.

Area of Research : *Particle physics and cosmic rays*

Publications :
Extensive air showers associated with penetrating particles (1949)

Career & Research :

Chowdhuri demonstrated that the density of penetrating events is proportional to the total particle density of an extensive air shower. She was interviewed by The Manchester Herald in an article called "Meet India's New Woman Scientist — She has an eye for cosmic rays", saying that "it is a tragedy that we have so few women physicists today."

She was appointed because Homi Bhabha was still establishing the Tata Institute of Fundamental Research, and contacted her thesis examiners for advice on outstanding graduate students. She joined the Physical Research Laboratory and became involved with the Kolar Gold Fields experiments. She moved to Kolkata to work at the Saha Institute of Nuclear Physics.[7] She taught physics in French.

Editorial

In Depth feature: Journey into the Cosmos-

A conversation with Physicist Sayan

INTERVIEWER: SURUCHI SINGH **BSC (H) PHYSICS II YEAR**

INTRODUCTION:

Hii Folks, get ready to meet a very inspiring personality who radiates immense intelligence and happiness - **"Mr. Sayan Saha".** He is a final year PhD Scholar at Indian Institute of Scientific Education and Research (IISER) Pune and serving as a visiting Researcher in the Department of Astronomy and Astrophysics at the Raman Research Institute (RRI) in Bengaluru. From struggling with English language in his Bachelor's to being a bright scholar at IISER Pune who calculated the mass of clusters in the late time Universe and studying Cosmic Microwave Background (CMB), his journey is truly phenomenal. His approach to Physics is really commendable and one can learn a lot from him. In addition to his research pursuits, he also holds a deep passion for science outreach among school children.

Meeting him at India International Science Festival (IISF) was quite unexpected but a life changing experience for me. Hope you will find the same inspiration that I got from him by reading this interview...

Ques) What inspired you to become a Physicist?

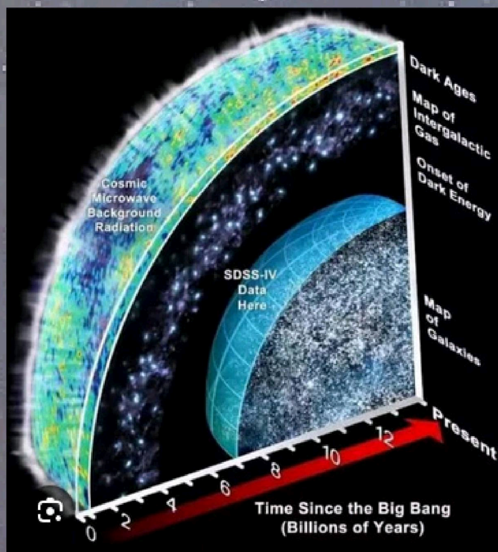
Mr. Sayan: As a physicist I think our job is to answer questions and from very childhood I would say that I had the curiosity of asking questions, you know why and what. I would ask questions about daily life; for example, why the sky is blue, why it becomes red around the Dusk and Dawn. So things like that kind of inspired me to know more and I just figured out on my way that I want to be a physicist and not just a physicist but someone who wants to learn. I would say every physicist is a student in some sense like even if someone is a professor or a faculty they are also still learning and as long as you have that urge of learning you are a scientist even if you are a school kid.

Ques) Can you explain your area of expertise in simple terms?

Mr. Sayan: Yes, basically I study Physics at its most macroscopic level. My area of research is the Universe as a whole; and when I say Universe I mean everything that you see in a broader sense - like you zoom out from the city you see Earth, you zoom out from Earth you see the solar system, you zoom out from the Star you see Galaxy, then you zoom out from the Galaxy you see clusters of galaxies and you see the Universe as a whole and I study that. I study how the whole Universe has evolved from a very small and hot dense plasma state to the state that we see right now hence, that's my area of expertise.

Ques) Please tell us more about your work on CMB.

Mr. Sayan: The Cosmic Microwave Background (or CMB) as I like to say, is basically snapshot of the Big Bang and it's very amazing that we have the image for that. We have actually captured the universe when it was only 300,000 years old. It's kind of amazing to think about that and the way you should think about it is - You see things in Sky, you see things in past and you can see galaxies which are like millions of light years away which means that they are actually billions of years past and the last thing like looking further and further, the last that you can see is the cosmic microwave background which is basically the baby picture of the Universe and just like the freckles of a baby you see the freckles in the CMB. It tells you about its baby state and how it became what it is today. The universe that we see today is the evolution of the CMB. You can think of it analogous to someone growing up from a baby to a grown person. So yes, CMB is the baby picture of the universe in simple terms.



Ques) What are some of the biggest challenges you face in your research?

Mr. Sayan: In terms of competition, the field is really competitive. There are competitions in two aspects- Sometimes you do some research and then some other group in the world is also doing that research. Sometimes they might publish earlier than you. You may have been working on it for a long time and maybe you were just going to publish it and then someone has independently published it before you. It may not be exactly what you did but even if it is somewhat close to your work then your work becomes kind of less hyped.

Another challenge is the complexity of the data. When you're dealing with observations of the Universe, the data can be vast and intricate. Analyzing and interpreting this data accurately can be a significant challenge. Sometimes, you encounter unexpected results, and understanding whether it's due to an error, a new phenomenon, or something else is part of the challenge.

Additionally, securing funding for research projects is often a challenge. Research in cosmology and astrophysics requires sophisticated instruments and technology, and obtaining the necessary financial support can be competitive and demanding.

Ques) Have there been any unexpected or surprising discoveries in your field that you find particularly fascinating? Has these discoveries influenced you in some way?

Mr. Sayan: Yes, the discovery of dark energy, for instance, was unexpected and challenged existing theories. It suggested that the expansion of the universe is not slowing down, as previously thought, but accelerating. This finding has led to a reconsideration of fundamental concepts in cosmology.

Similarly, the cosmic microwave background provided a snapshot of the early universe, offering insights into its initial conditions and evolution. The small fluctuations or "freckles" in the CMB have been instrumental in understanding the formation of galaxies and large-scale structures.

So, while these discoveries were not made during my specific time of research, learning about them has certainly influenced my perspective and understanding of the dynamic nature of the universe.

Ques) What does Physics really mean to you?

Mr. Sayan: Physics for me is like asking questions and then finding out its answer. We try to find out patterns we see , we try to understand why this certain phenomenon happened instead of just ignoring it. We try to find out the relation between the cause and the observation. For me, Physics is everywhere; it is in Biology , it is in Chemistry and in everything you can go deeper and deeper and you will find some fundamental physics law which is holding it. Physics is a way or a method to relate between cause and effects and as a physicist your job is to find patterns and kind of try to predict what will happen. Then you experiment . For example : I found the pattern between these two things if I change the cause like this how the effect will be changed and then you see with observation does it happen it's kind of like the cyclic way of doing Physics.

Ques) How do you balance your work in Physics with your personal life and hobbies?

Mr. Sayan: In terms of hobbies, I used to be in a rock band in my college times. I was a guitarist and lead vocalist at that time. I even formed a band in RRI (Raman Research Institute) in the beginning and we actually performed one or two times as a band and when the research started becoming more intense, I had less time to balance. Secondly I have a passion for working out and Sports so I go to gym or go for a run almost every day because that makes me sane. After working till 6:00 p.m, I go for a run or maybe go hit the gym that relaxes and de-stresses me. I also like to travel. When I was

in Switzerland for a year, I travelled almost 42 weeks. These 42 weekends I travelled to Norway, France, Germany, Finland, Italy and every place in Switzerland. Also, I do like to call my friends. I would say I try my best to make it as balanced as possible but sometimes when we have deadlines, I might not have a weekend off. But to balance both work and fun is a very important thing in the life of a researcher, otherwise one can end up in Depression or burnout. It's kind of a cyclic process ; if your mind is well rested then you can have better productivity.

Ques) Who is your role model/mentor who has influenced your journey in Physics?

Mr. Sayan: From my school life Richard Feynman has been my role model. I read this book called "Surely you're joking Mr Feynman " and it was amazing. Stephen Hawking also influences me, I read his "A Brief History of Time '' when I was in 11th or 12th. I read that book in Bengali actually as at that time I didn't know how to read English so I read it in Bengali translated version and that made me really interested in Science. I like Richard Feynamn and Stephen Hawking because they humanize Science in a way that makes it very accessible and easy. They inspired me to work hard because I used to be an average student. I'm not very talented like a lot of people in our field but I worked hard. Around Masters I became more serious about physics and then I thought I have to do this and then I worked hard and whatever I am or whatever I have achieved is less about my intellect or talent but more about working hard.

Ques) How did you get into Cosmology?

Mr. Sayan: In my Bachelors I was very much interested in quantum mechanics. I actually wanted to do Particle Physics. So in my masters I actually picked up Particle Physics under my supervisor in IISER Pune. I was doing my Master's thesis in Particle Physics but then some things didn't work out and I didn't feel like I wanted to continue Particle Physics anymore. So I thought maybe I have to do something else. I was not even that much into Cosmology or Astrophysics, so then it was my second choice. Then I approached my supervisor Tarun who's a Pioneer in the field. I didn't had any hope that he would take me in the team because I didn't had any background in cosmology but he gave me a chance and I had to learn cosmology from scratch in my masters. I joined him in 2020 and I went to IUCAA (Inter-University Centre for Astronomy and Astrophysics) for 2 months after that Covid hit and had a cosmology course. So this has been only 3 and a half years since I've been in the field.

Ques) How do you stay motivated and inspired for your work?

Mr. Sayan: It's a very important thing to stay motivated because sometimes when you're working on something for about 3-4 months and things don't go your way it's very depressing. In the beginning I used to be very demotivated when something didn't work out. I used to talk to my seniors. I also had counseling at some point. I was very depressed about some stuff going on in my life so I used to talk to counselors and that helped me a lot. I used to talk to my friends. I think talking to your friends helps a lot. Even if someone doesn't know about your work, just talking to someone who you can actually count on really helps you. They can actually motivate you. I would say I was fortunate enough to have people in my life to keep me motivated and I get motivated from a lot of people.

iQues) How do you approach collaboration and teamwork in your scientific work?

Mr. Sayan: Usually in research when you start PhD, your supervisor is supposed to take care of your collaboration or define the problem that you are going to work on. The first part of my research or my first paper was also kind of defined. My supervisor already had some people like his ex- PhD students who were doing Post-Docs or are scientists in some place in the world so we used to collaborate online. When the work was done, I started to look up things on my own and that's how I learned about my supervisor Julian in Switzerland. I applied for "Swiss government Excellence Fellowship" during my uh PhD. Things worked out for me and I got the fellowship. I went to Geneva for a year to finish that work that was on clusters. Apart from my work on CMB I also work on clusters. Clusters are clusters of galaxies that are formed way after CMB, since the CMB comes from the early picture of the Universe, it contains valuable information about the large-scale structure of the universe, including the formation of galaxy clusters. Utilizing the data from the CMB to study clusters is a fascinating approach . It interacts gravitationally with the Clusters. Clusters are actually Halos of dark matter. We can't see dark matter but we can see the gravitational effect of the matter. It affects light gravitationally. Mass bends light. Dark matter has mass that's why it bends light and CMB when it comes through the Clusters it bends the light like a lens we call it gravitational lens and it gives us the light. Looking at the distorted light or CMB I actually calculated the mass of clusters in the late time universe.

Ques) How were you as a BSc student?

Mr. Sayan: As a BSc student I was pretty average, I scored 71% in it. First I would say when I started I had Bengali board in my school life so I had this problem of language. I used to think about Physics in Bengali and in my first semester, when I was writing I couldn't even think about what I had to write. I couldn't write anything in the exam and I got a very bad grade in the first Mid semester. I got very depressed. I thought I couldn't make it. I'm from a very rural place in North Bengal so I didn't have the right exposure. Also I didn't know English whereas my friends in College were very smart and they spoke English so I used to feel intimidated. In my bachelors I didn't do well in my first year at least. Then I started learning English as a way of communicating , still I didn't do well in my Bachelor's exam. But in JAM and JEST they don't require Bachelor's marks. I gave JAM and JEST and my ranks were AIR 472 and 242 respectively. I got IISER Pune and that's how I ended up where I am today.

Ques) Do you think that research in India is not that up to the mark when compared to the rest of the world?

Mr. Sayan: It isn't true at all that research in India is not that good. I would say that in India we are actually doing very good research in a lot of different fields and at times I would say it is even better in some aspects. It's just that in terms of research India is very competitive and exposure-wise there might be a difference. It's very competitive to actually find a research position in India because we have so many good students throughout the country and we don't have that many research institutes. But if you go to a very good Research Institute like TIFR , IUCAA or any other research institute then you will see that the research we do is world quality. So it is false to say that research in India is not that good. But I would say that you'll have to get ready to face the competitions.

For more information/ query, contact Mr. Sayan at:

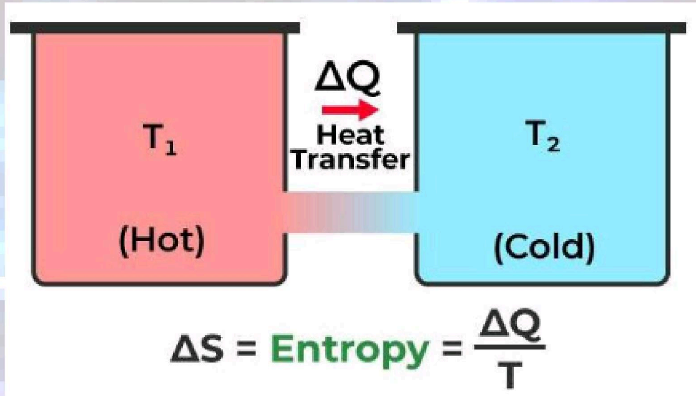
Website: Sayan Saha
Email Id: sayan.saha@students.iiserpune.ac.in

From Order to Chaos:

Exploring the Enigmatic World of Entropy

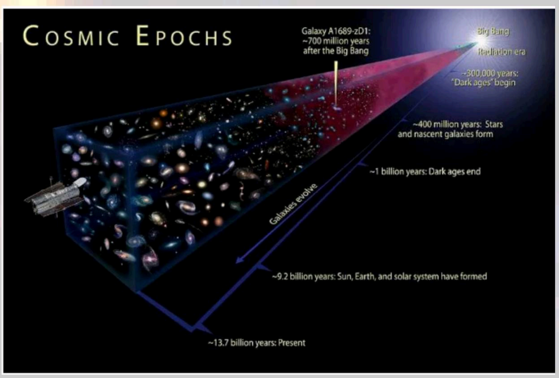
Suruchi Singh
BSc (H) Physics II Year

Today we are going to dive into one of the most important, yet least understood concepts in all of physics i.e. ENTROPY. It's the concept that pops up in every corner of physics, from the way your coffee cools down to the fate of the entire universe.

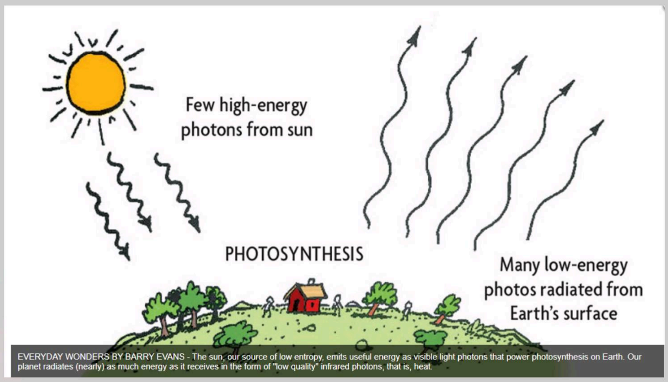


Imagine a perfectly organized room, everything perfectly in its place. Now, picture a mischievous toddler running through and leaving a trail of glorious chaos. That, in essence, is entropy. It's not just about scattered toys, though; it's a fundamental principle governing the universe, stating that **disorder, or the spread of usable energy, always increases over time.**

Another way of thinking about entropy can be : Consider that you have a perfectly organized Rubik's cube. As you play with it, the colors get more and more mixed up, increasing the **"entropy"** of the cube. In the same way, energy tends to flow from concentrated (low entropy) to spread out (high entropy). But if total entropy is constantly increasing and anything we do only accelerates that increase, then how is there any structure left on earth? How are there hot parts separate from cold parts? How does life exist? Well, if the earth were a closed system, the energy would spread out completely, meaning, all life would cease, everything would decay and mix, and eventually, reach the same temperature. But luckily, earth is not a closed system, because we have the sun. The sun gives us the required low entropy. The energy that we get from the sun is more useful than the energy we give back. It's more compact, it's more clumped together. Plants capture this energy and use it to grow. And with each level of the Food Chain, it is more spread out. So basically we are using the Sun's compact energy to do the useful work. Without a source of concentrated energy and a way to discard the spread out energy, life on earth would not be possible. Therefore life itself is a consequence of the second law of thermodynamics.



credits: forbes magazine



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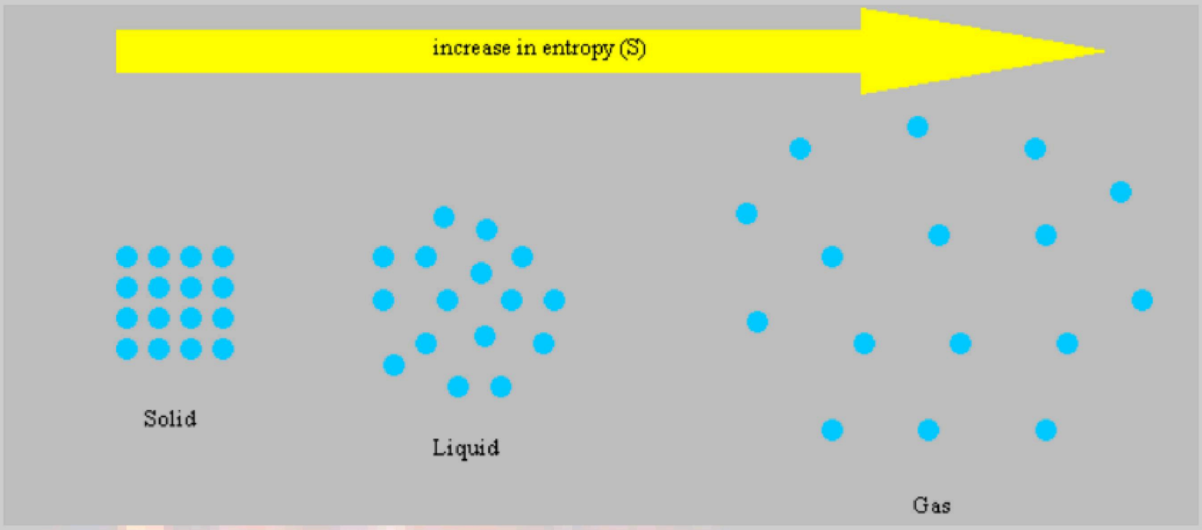
Now an interesting question arises here- “If Earth is getting its low entropy from the Sun, where does the Sun get its low Entropy from?? Well the answer to that is Big Bang. According to the Past Hypothesis, entropy at the beginning of the Universe ie THE BIG BANG was the lowest. It means everything was highly ordered at the time of Big Bang. As the time passed the Universe started to cool down, the matter started to clump together due to gravity, thus increasing its Kinetic Energy. This kinetic energy resulted in loss of energy in form of heat therefore decreasing the amount of useful energy and hence increasing the entropy. With time the Universe took its form as we see today using this low entropy.

According to researchers, Black Holes are another source of low entropy. And this entropy is directly proportional to its surface area meaning large Blackholes must have greater entropy. This



credits: kentchemistry.com

means that Black Holes must have a temperature and they must emit radiation. This fact was proven by Stephen Hawking and the radiation emitted by a blackhole is known as the “Hawking Radiation". But if the blackholes do emit radiation why does it appear black?? Well that is because the radiation emitted by them is pretty weak so they appear black. It is due to entropy that we have a direction of time and a clear difference between the Past and the future. This is expected to continue until eventually, the energy gets spread out so completely that nothing interesting will ever happen again. This is the **heat death of the universe.** By now you must be thinking that increasing entropy is not a very good thing, but I would like you to think of it as Tea and milk. When both are separated nothing much happens. But when we start to mix it , then beautiful patterns emerge and in an instance everything goes back to normal. Therefore, low entropy and high entropy, both are not very interesting, it’s in the middle that great things are observed.

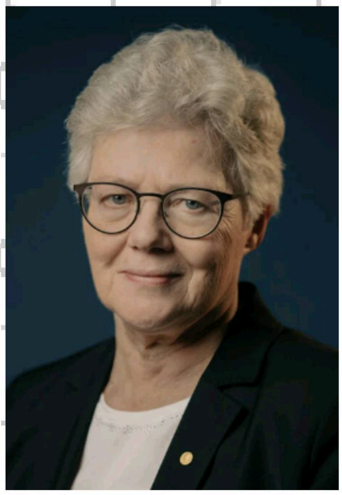
What is an Attosecond ?

Dipakshi Sarma
B.Sc(Hons)Physics, 2nd year

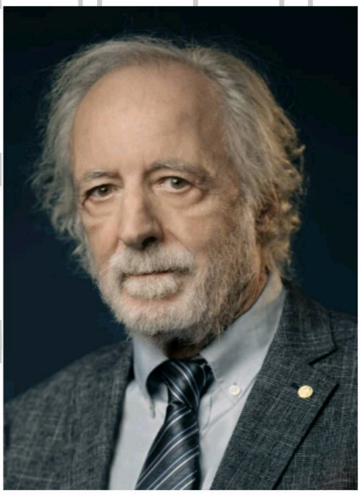
Whenever we open a new window in the universe, we discover something new, whether it's figuring out how to see to greater distances with telescope or down to smaller size scales like with microscopes or perhaps expanding our vision to new wavelengths of light or via exotic means such as in neutrinos or gravitational waves. Well the 2023 Nobel Prize in Physics has been awarded to three Physicists for opening just such a new window – but its not a window to a new size scale or a new mode of seeing- it's for a new window in time. It's for Attosecond Physics- the billionth of a billionth of a second that represents the timescale inside of atoms.

Every 230 million years the solar system completes one orbit around the milky way. Every 243 years Venus passes between the Sun and the Earth. Every Year monarch butterflies migrate between the United States and Mexico. Every 3 seconds a Kinesin Protein travels down one of our cytoskeletal filaments. As we look to smaller and smaller scales we find faster and faster processes. The trend continues to the smallest scales- the motion of individual atoms during chemical reactions. Their timescale is not measured in nanosecond or microsecond but in attoseconds.

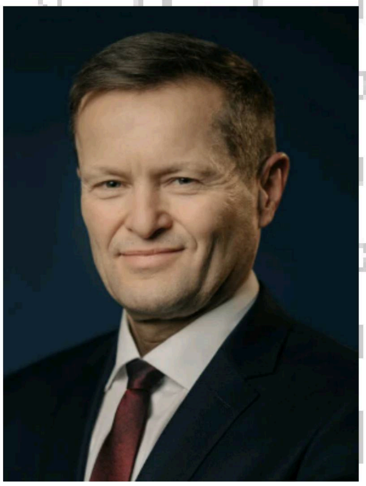
The name of three scientists won the Nobel Prize in physics for giving us the first split-second glimpse into the superfast world of spinning electrons, a field that could one day lead to better electronics or disease diagnoses, are as follows :



Anne L'Huillier
Lund University
Sweden



Pierre Agostini
The Ohio State University
Columbus, USA



Ferenc Krausz
Max Planck Institute of
Quantum Optics, Germany

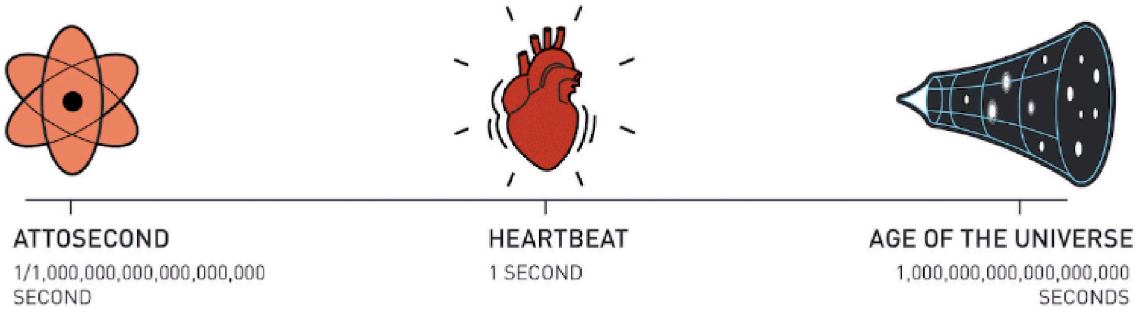
Electrons move so fast that they have been out of reach of human efforts to isolate them, but by looking at the tiniest fraction of a second possible, scientists now have a "blurry" glimpse of them and that opens up whole new sciences.

Previously, scientists could study the motion of heavier and slower-moving atomic nuclei with femtosecond (10^{-15}) light pulses. One thousand attoseconds are in 1 femtosecond. But researchers couldn't see movement on the electron scale until they could generate attosecond light pulses – electrons move too fast for scientists to parse exactly what they are up to at the femtosecond level.

How long is an attosecond?

"Atto" is the scientific notation prefix that represents 10^{-18}, which is a decimal point followed by 17 zeros and a 1. So a flash of light lasting an attosecond, or 0.000000000000000001 of a second, is an extremely short pulse of light.

In fact, there are approximately as many attoseconds in one second as there are seconds in the age of the universe.



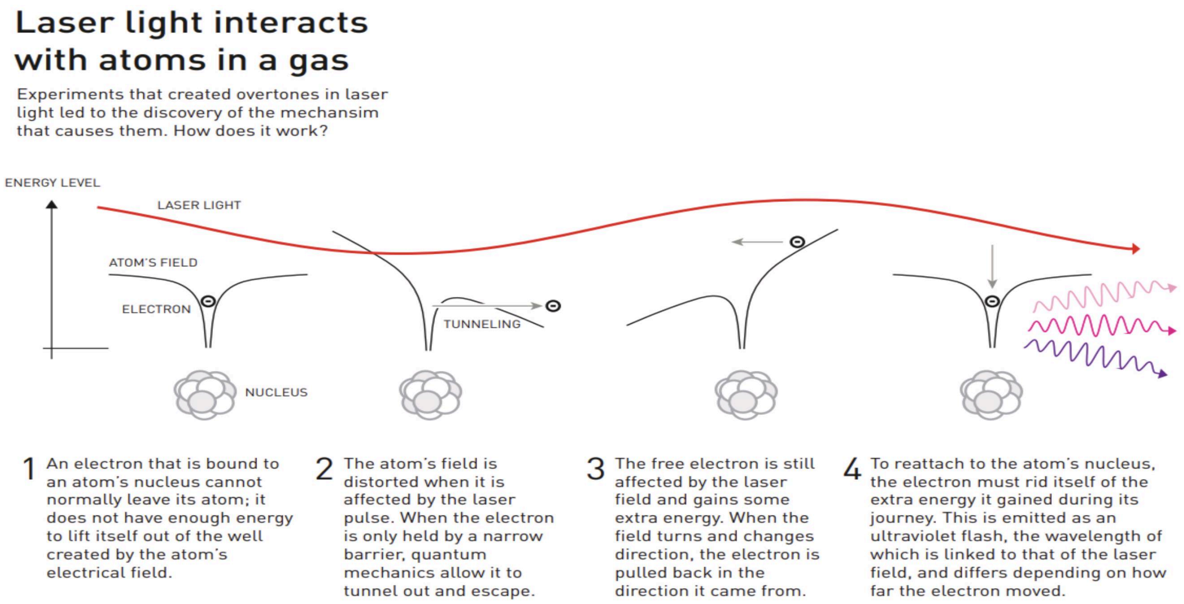
Isn't that quite amazing ?

Attosecond Pulses

The scientists, who worked separately, used ever-quicker laser pulses to catch the atomic action that happened at such dizzying speeds—one quintillionth of a second, known as an attosecond—much like the way photographers use fast shutters to capture a hummingbird feeding. As an analogy, imagine a camera that could only take longer exposures, around 1 second long. Things in motion, like a person running toward the camera or a bird flying across the sky, would appear blurry in the photos taken, and it would be difficult to see exactly what was going on. Then, imagine you use a camera with a 1 millisecond exposure. Now, motions that were previously smeared out would be nicely resolved into clear and precise snapshots. That's how using the attosecond scale, rather than the femtosecond scale, can illuminate electron behaviour.

Lasers can now generate light pulses down to 100 attoseconds thereby enabling real-time measurements on ultrashort time scales that are inaccessible by any other methods. Scientist at the Max Born Institute for Nonlinear Optics and Short Time

Spectroscopy (MBI) in Berlin, Germany have now demonstrated timing control with a residual uncertainty of 12 attoseconds. This constitutes a new world record for the shortest controllable time **scale.**



Application Of Attosecond Physics

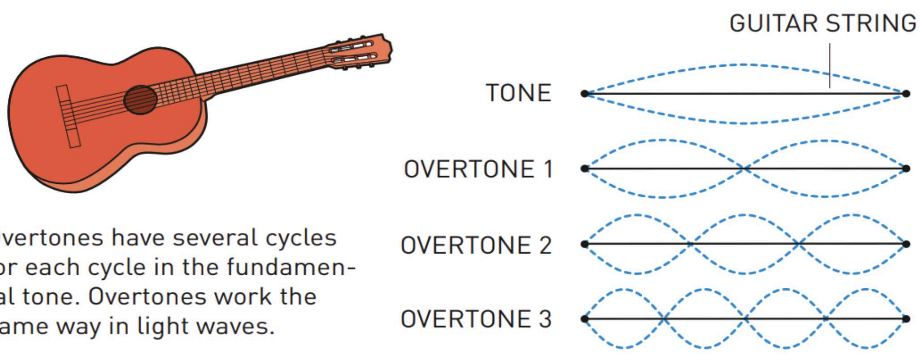
- The first application of attosecond pulses was to look at electron motion in atoms and molecules. Electrons travel the breadth of their orbitals in a handful of attoseconds, or rather the fuzzy cloud that defines the electron in an atom changes on that timescale. By hitting these clouds with attosecond pulses we can study the shapes and dynamics of these electrons.
- Attosecond pulses can also be used to manipulate electrons on a tiny timescale. These can further be used in medical diagnosis.
- Another very exciting possibility is the creation of ultrafast electronics. This can lead to the possibility to increase the power of computers by a factor of 100,000 this way !!

Women In Physics

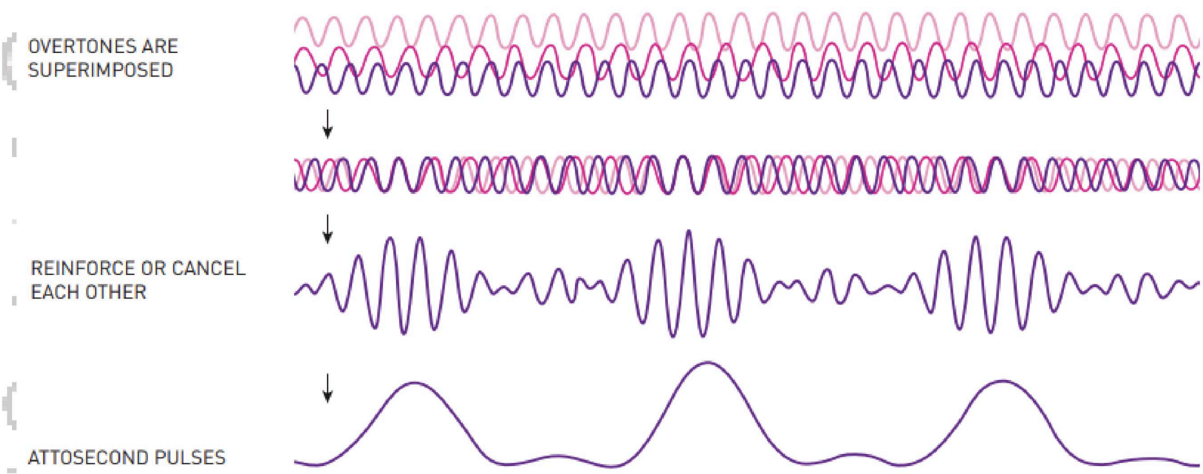
Anne L'Huillier, a French Physicist of Lund University in Sweden, is the fifth woman to receive a Nobel in physics, preceded by Marie Curie, Maria Goeppart Mayer, Donna Strickland and Andrea Ghez.

L'Huiller in her banquet speech said," 20 years ago, Marie Skłodowska Curie was the first woman to be awarded the Nobel Prize in Physics. I am the fifth. For more than 100 years, only two women were awarded the Nobel Prize in Physics. During the last five years, three women have been awarded the Nobel Prize in Physics! I hope that this is a new trend, which will inspire new generations!"

In 1987, **Anne L'Huillier** discovered that many different overtones of light arose when she transmitted infrared laser light through a noble gas. Each overtone is a light wave with a given number of cycles for each cycle in the laser light. They are caused by the laser light interacting with atoms in the gas; it gives some electrons extra energy that is then emitted as light. Anne L'Huillier has continued to explore this phenomenon, laying the ground for subsequent breakthroughs.



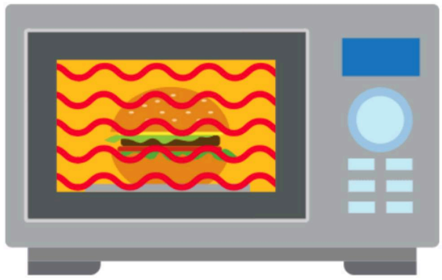
Overtones have several cycles for each cycle in the fundamental tone. Overtones work the same way in light waves.



From Radar Candy to Instant meals: The Science Behind Microwaving

By Suruchi Singh
B.Sc. (H) Physics II year

Ever wonder how shoving your food in a metal box and blasting it with invisible rays heats it up in minutes? It's all thanks to a cool accidental discovery during World War II, and some science that's actually pretty easy to understand.



Credits: FWD Life

So, picture this: it's 1945, and Percy Spencer, an American engineer, is tinkering with a **RADAR** instrument called a magnetron, a device that produces high-intensity microwaves that could reflect off planes. Suddenly, he realizes that the candy bar in his pocket has melted! Turns out, the **microwaves** the machine was generating were the culprit. He experimented with other things, like popcorn kernels and eggs, and voila, the microwave oven was born.

But how does this magic happen? Microwaves belong to the electromagnetic spectrum of radiation or in simple terms light energy. All light energy travels in waves of oscillating electric and magnetic fields. The higher the frequency (think of it as the speed of the wave's oscillation), the more energetic. Gamma rays and X-rays have the highest frequencies; microwaves and radio waves, the lowest. Since microwaves has a much lower frequency , they're not strong enough to mess with your food on a molecular level, unlike the high frequency X- rays you get at the dentist.

By Science we know that this oscillating electric field is going to apply force on charged particles- like electrons in a molecule. When this field is applied on **water (a polar molecule)**, the positive and negative regions are pulled and pushed in different directions causing the water molecule to vibrate. This vibration creates **friction**, which is basically microscopic bumping that translates to heat. That's why foods high in water, like your instant noodles, heat up so quickly in the microwave.

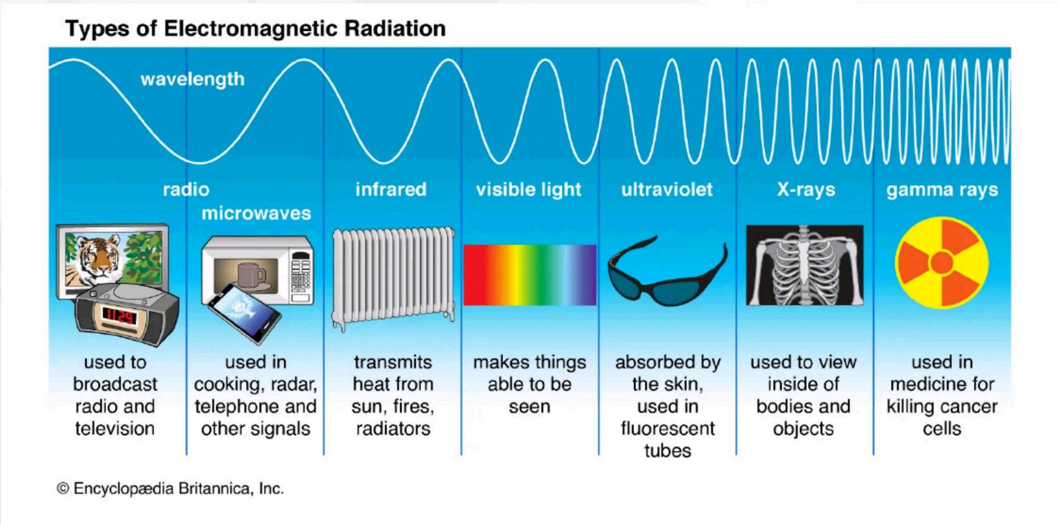
So microwaves heat food molecules mechanically, through friction—but they don't alter them chemically.

The heart of a microwave oven is a special device called a magnetron. When you turn it on, the magnetron uses electricity and magnetism to create a stream of invisible waves called microwaves. These waves are then directed into the cooking chamber, where they bounce around the metal walls.

Unlike traditional ovens that heat food from the outside in, microwaves can penetrate a few centimeters into your food. This is because they interact with the water molecules inside, making them vibrate rapidly. This vibration creates heat, which cooks your food from the inside out.

But wait, what about metal in the microwave? It's a conductor, meaning its electrons move freely and can get all riled up by the microwaves. This can cause sparks, especially at sharp edges or points like the prongs of a fork. That's why it's important to **avoid putting metal objects** in the microwave, unless they're specifically designed for it (like those fancy metal crisping trays).

So, the next time you heat up some leftovers, remember: it's all thanks to some accidental candy melting, some science magic, and a whole lot of jiggling water molecules. Pretty cool, right?



Credits: Britannica.com

Beyond the Sunbeam:

A glimpse into the World of

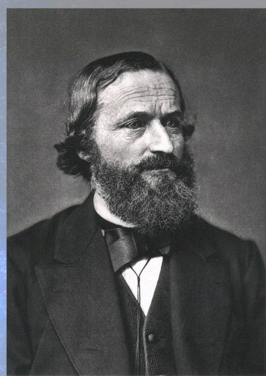
Blackbody Radiation

Suruchi Singh
BSc (H) Physics - II Year

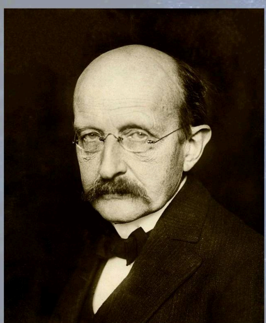
Introduction:

Welcome to the captivating world of blackbody radiation, where the universe paints its masterpiece with the vibrant strokes of energy and light. From the warmth of a sunlit day to the mysteries of distant galaxies, blackbody radiation holds the key to unlocking the secrets of the cosmos. In this journey, we'll delve into the historical roots, explore the theoretical depths, and unveil the fascinating applications of blackbody radiation.

Historical Origins:



Our voyage begins in the 19th century, amidst the tireless efforts of physicists grappling with the enigma of thermal radiation. Among them, Gustav Kirchhoff's conceptualization of the blackbody – a theoretical entity that absorbs all incident radiation regardless of wavelength – marked a pivotal moment in scientific inquiry. This concept laid the groundwork for subsequent investigations into the spectral distribution of blackbody radiation, igniting a revolution that would reshape the landscape of physics.

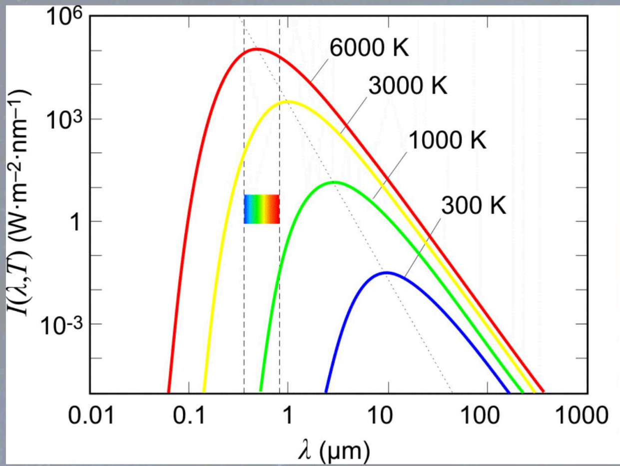


Theoretical Depths:

Enter Max Planck, whose groundbreaking work at the turn of the 20th century revolutionized our understanding of blackbody radiation. Planck's daring proposal of quantized energy packets, known as quanta, challenged the prevailing classical view and laid the foundation for modern quantum mechanics. His eponymous Planck's Law describes the spectral distribution of blackbody radiation with remarkable accuracy, earning him a place of honor in the scientific pantheon.

Clarification of Planck's Law:

Planck's Law describes the distribution of energy emitted by a blackbody at a given temperature across different wavelengths. The equation shows how the spectral radiance (brightness) of the radiation depends on both the wavelength and the temperature of the blackbody. As the temperature increases, the peak of the emitted radiation shifts to shorter wavelengths, leading to a more energetic spectrum.



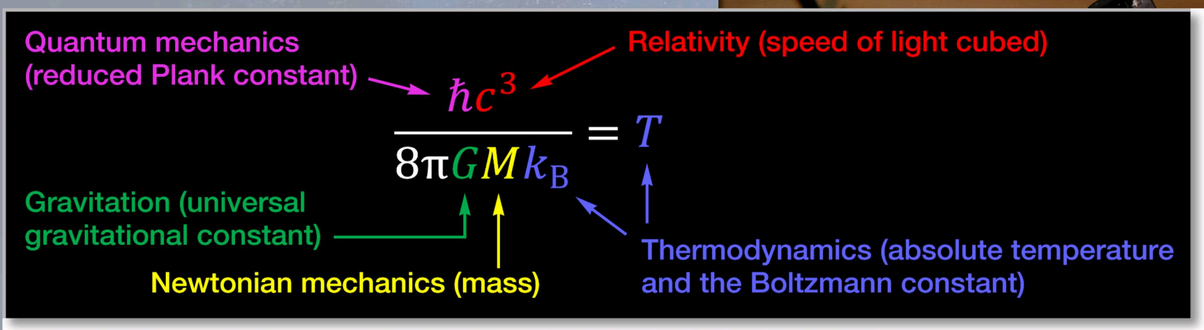
Everyday Wonders:

Let's ground our exploration in the familiar realm of everyday experience. Consider a sunny afternoon, where the Sun's radiations bathes the Earth in warmth and light. What you're feeling is more than just sunlight – it's the intricate interplay of electromagnetic waves emitted by the Sun, each carrying the signature of blackbody radiation described by Planck's Law. From the Sun's fiery core (approximately 15 million Kelvin) to the Earth's surface (around 300 Kelvin), this dance of energy shapes our world and fuels the cycles of life.

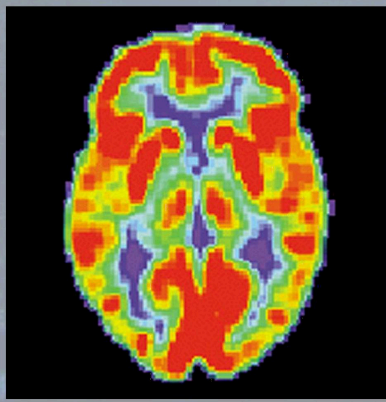
In addition to warmth, blackbody radiation also influences the colors we perceive in the world around us. Objects absorb and emit radiation according to their temperature, which affects the wavelengths of light they reflect. This phenomenon, known as thermal emission, plays a crucial role in the appearance of objects, from the red glow of hot metal to the comforting warmth of a campfire.

Practical Implications:

The influence of blackbody radiation extends far beyond the celestial stage. Infrared thermography, a modern marvel born from the principles of blackbody radiation, enables us to peer into the invisible realm of heat and energy. This technology, based on the analysis of the emitted radiation, has diverse applications:



- Diagnosing electrical faults: In machinery, abnormal temperature fluctuations can indicate potential problems. Thermography allows for non-invasive detection of overheating components, enabling preventative maintenance.



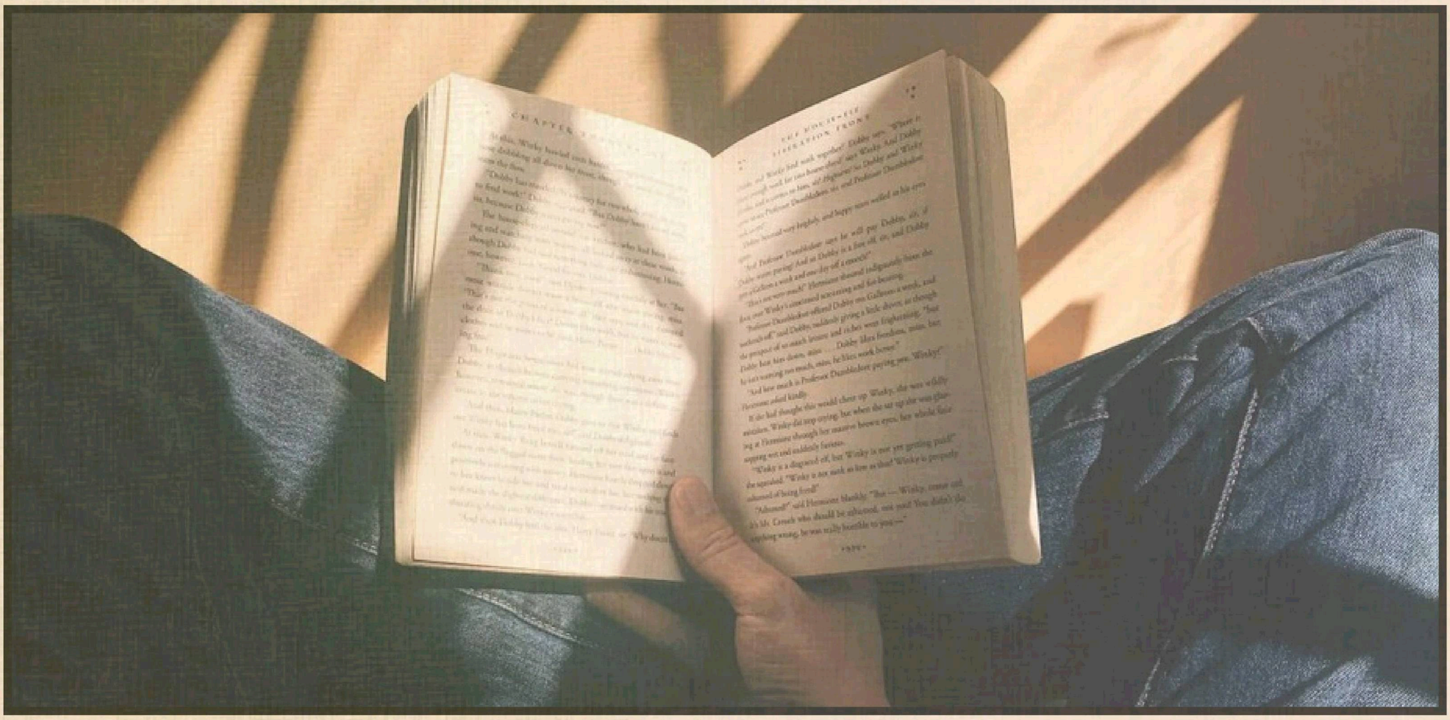
- Medical applications: From detecting tumors with abnormal heat signatures to monitoring blood flow, thermography offers valuable diagnostic tools for medical professionals. This technology also aids in assessing inflammation, monitoring wound healing, and guiding minimally invasive surgeries, contributing significantly to a wider range of medical procedures.

- Expanded Practical Implications: Infrared thermography is also widely used in building inspections to identify areas of heat loss or moisture intrusion, helping improve energy efficiency and prevent structural damage. Additionally, in the field of archaeology, thermography assists in the detection of buried structures or artifacts by revealing differences in thermal conductivity between materials

Conclusion:

As we conclude our journey through the fascinating world of blackbody radiation, let us look at the intricate tapestry woven across time and space. From the vast cosmic expanse to the warmth of a sunlit day, blackbody radiation serves as a powerful reminder of the interconnectedness of the universe. This exploration doesn't just offer a glimpse into the scientific past, but also ignites a spark of curiosity, urging us to continue unraveling the universe's mysteries. So, let us embrace the adventure and delve deeper into the boundless wonders of blackbody radiation, fueled by the knowledge that our imagination is the only limit to discovery.

Refresh Thyself



"Refresh your mind, dive into a book, and let the pages rejuvenate your spirit."

Exploring the Legacy:10 Facts about Raman Effect

1. **Discovery:** The Raman Effect was discovered by the Indian physicist Sir C.V. Raman in 1928 while he was studying the scattering of light in liquids.

2. **Phenomenon:** The Raman Effect is a phenomenon in which the wavelength of light changes when it interacts with molecules, leading to a shift in its energy and frequency.

3. **Scattering:** When light passes through a material, it interacts with the molecules in the material, causing the light to scatter in various directions.

4. **Inelastic Scattering:** Unlike Rayleigh scattering, which is elastic scattering and does not change the energy of the light, Raman scattering is inelastic, meaning the energy of the scattered photons differs from that of the incident photons.

5. **Molecular Vibrations:** The Raman Effect occurs due to the interaction between light photons and the vibrational modes of the molecules in the material. When light interacts with molecules, it can excite or de-excite the molecular vibrations.

6. **Raman Spectroscopy:** Raman spectroscopy is a technique based on the Raman Effect, which is used to study molecular vibrational, rotational, and other

low-frequency modes in a system.

7. **Applications:** Raman spectroscopy has diverse applications in various fields including chemistry, biology, material science, pharmaceuticals, and forensic science. It is used for chemical analysis, identification of substances, and characterization of materials.

8. **Non-Destructive:** Raman spectroscopy is a non-destructive analytical technique, meaning it does not require sample preparation and can be performed on samples without altering or damaging them.

9. **Instrumentation:** Raman spectroscopy instruments typically consist of a laser light source, a monochromator to filter the scattered light, and a detector to measure the intensity of the scattered light at different wavelengths.

10. **Advancements:** Over the years, advancements in Raman spectroscopy instrumentation, such as the development of compact and portable devices, have expanded its use in various fields including environmental monitoring, biomedical diagnostics, and archaeological studies.

Book Recommendations :

"Somewhere, something incredible is waiting to be known." - Carl Sagan