Indian Association of Physics Teachers

Sub-Regional Council (Vidarbha)

Sub-RC 08E

International Year of Quantum Sciences and Technology 2025

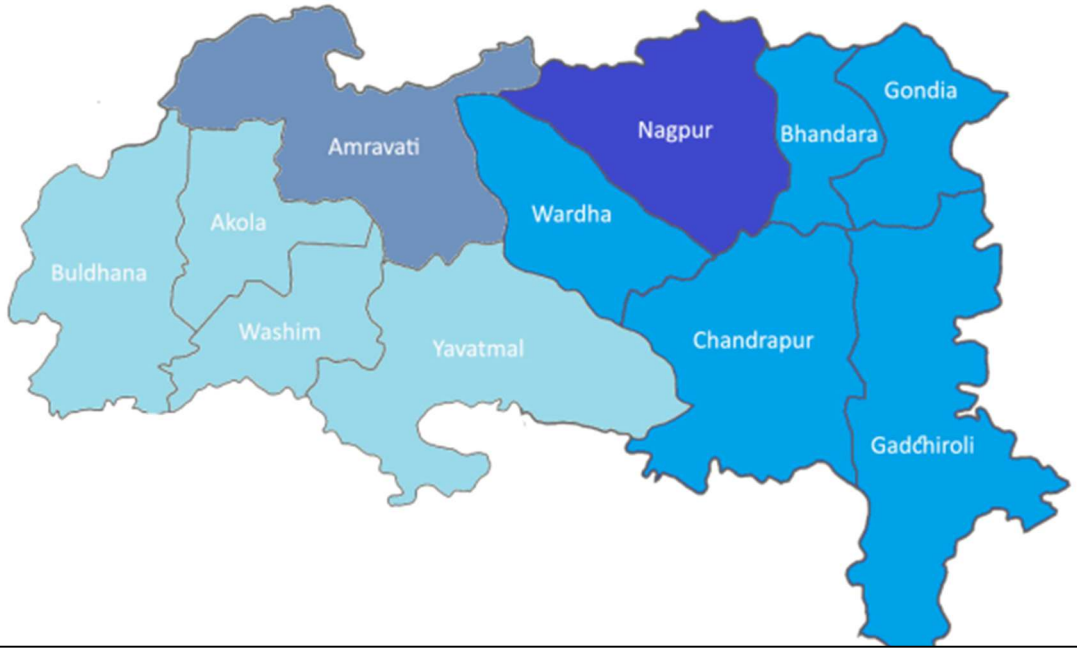
8th April 2025

Quantum Doodles: De Broglie's Matter Wave Hypothesis leading to the Electron Microscope

Resource Person: Prof. P.K. Ahluwalia, President, IAPT Central

Date: 8th April 2025 Time: 12:30 PM to 2:00 PM

Venue: Department of Physics, RTMNU, University Campus



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REPORT of Workshop on

International Year of Quantum Sciences and Technology 2025

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Indian Association of Physics Teachers

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Ref No.: CORR/2025/GEN/041 Date: 05/04/2025

Dear Faculty Members & Students,

As part of the **International Year of Quantum Science and Technology 2025**, the Indian Association of Physics Teachers (IAPT) is excited to announce a **Quantum Physics Outreach Program** aimed at postgraduate students and educators. This initiative seeks to enhance awareness of quantum science and its related technologies through focused discussions on significant topics. Post graduate students of physics are invited (physically) to attend the programme at PGTD Physics RTMNU, Nagpur. This activity is jointly organized with VUPTA in association with PGTD Physics RTMNU.

Program Details:

Quantum Doodles: De Broglie's Matter Wave Hypothesis leading to the Electron Microscope

Resource Person: Prof. P.K. Ahluwalia, President, IAPT Central

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We also warmly invite all faculty members to attend this program online via Zoom. Additionally, the office bearers of **IAPT SRC-08E** and **VUPTA** are encouraged to attend in physical mode at the venue.

Your participation will greatly enrich the discussions and help foster a deeper understanding of quantum physics among our community.

Zoom link of the session can be shared to the faculty members on their demand.

Looking forward to your participation.

Dr S B Kondawar	Dr Umesh Palikundwar	Dr Govinda Lakhotiya
Convener	Organizing Secretary	Coordinator

Dr O P Chimankar Professor & Head will chair the session.

Prof. S. W. Anwane
President
IAPT SRC-08 E

OFFICE: Department of Physics, Shri Shivaji Science College, Congress Nagar, NAGPUR 440012
e-mail: swanwane2000@yahoo.com

Table Programme

International Year of Quantum Science and Technology 2025

Program Details:

Quantum Doodles: De Broglie's Matter Wave Hypothesis leading to the Electron Microscope

Resource Person: Prof. P.K. Ahluwalia, President, IAPT Central

Date: 8th April 2025 Time: 12:30 PM to 2:00 PM

Venue: Department of Physics, RTMNU, University Campus

Time	Activity
12:15-12:30	Joining Zoom Platform
12:30-12:35	Introductory Remark by **S W Anwane** (President SRC-08E IAPT) & Introduction to Speaker Prof P K Ahluwalia
12:35-13:15	Address by **Prof P K Ahluwalia**
13:15-13:25	**Dr Umesh Palikundwar** (VUPTA President) : To conduct interaction through Question & Answer
13:25-13:30	**Prof O P Chimankar** (Prof & Head PGTD Physics RTMNU): Remarks as a session chair
13:30-13:35	Vote of Thanks by **Dr Govinda Lakhotiya**, Vice President SRC-08E IAPT

Join Zoom Meeting
https://us06web.zoom.us/j/85669210525?pwd=jtjr0PUHEs73usy1oT2G5CG2REhOSG.1
Meeting ID: 856 6921 0525
Passcode: 456889

PS: From many places in Vidarbha virtually students-teachers from class-rooms may join.

YOUTUBE link of the Programme

https://youtu.be/NpAYs5JYdA4

Report

Indian Association of Physics Teachers (IAPT) is the renowned organization working for physics teaching and teachers by conducting various academic programmes and activities.

IAPT Sub Regional Council for Vidarbha SRC-08 E in association with (i) Post Graduate Teaching Department of PHYSICS RTM Nagpur University (ii) Shri Shivaji Science College (iii) Vidarbha University Physics Teachers Association (VUPTA) organized **Quantum Physics Outreach Event** for the celebration of the 100 years of Quantum Sciences and Technology. The outreach programme was organized at Post Graduate Teaching Department (PGTD) of Physics, Rashtrasant Tukdoji Maharaj Nagpur University (RTMNU) ON 8th April 2025 in afternoon session from 12:30 PM – 2:00 PM. It was telecasted on ZOOM platform to reach to the PG students of various colleges and university PG departments in Vidarbha that include (i) PGTD Physics Gondwana University (ii) PGTD Physics SGB Amravati University (iii) Shivaji Science College Nagpur (iv) M P Deo Dharampeth Science College, Nagpur (v) SFS College, Nagpur (vi) Mohota Science College, Nagpur (vii) Kamla Nehru Science College, Nagpur (viii) Shivaji Science College Amravati, (ix) Vidya Bharti College, Amravati, (x) Shivaji Science College Akola.

Prof. S. W. Anwane as President IAPT SRC-08E, Dr. G. V. Lakhotia as Vice-President IAPT SRC-08E and event coordinator, Dr. Halim Ahamad as Secretory IAPT SRC-08E, Dr. G. L. Jadhav as Treasurer IAPT SRC-08E for this event was present and done magnificent arrangement for the event. The convenors of the event were (i) Dr. S. B. Kondawar Senior Professor PGTD Physics RTMNU (ii) Dr. Umesh Palikundawar Associate Professor PGTD Physics RTMNU and President VUPTA. Prof O P Chimanka, Professor and Head, PGTD Physics RTMNU chaired the session.

About 70 students and 15 teachers physically attended this event at the PGTD Physics RTMNU and in online mode on ZOOM platform all over 150+ students from different universities and colleges were participated in this event. The lecture on **Quantum Doodles: De Broglie's Matter Wave Hypothesis** leading to the Electron Microscope was done via online zoom meeting: (i) PGTD Physics Gondwana University (ii) PGTD Physics SGB Amravati University (iii) Shivaji Science College Nagpur (iv) M P Deo Dharampeth Science College, Nagpur (v) SFS College, Nagpur (vi) Mohota Science

College, Nagpur (vii) Kamla Nehru Science College, Nagpur (viii) Shivaji Science College Amravati, (ix) Vidya Bharti College, Amravati,.

The event started at sharp 12:30PM with the introductory remarks Prof. S. W. Anwane while Dr. G. V. Lakhotia conducted the session under the chairmanship of Dr. O. P. Chimankar. Within minutes Prof. P K Ahluwalia started, he started with some reviews and beautifully explained where quantum physics is applicable in our day to day life. Also he mentioned about some pioneers in field like einstein and de-Broglie.

Prof. P. K.Ahluwalia commenced session with historical background and origins of the quantum sciences. He also mentioned one most heard phenomenon of Blackbody Radiation. In different minds different thoughts about light emerges out, for someone it is made of particles and for light is a wave traveling like ripples. Thoughts of Albert Einstein who named particles as photons and Max Plank also involved. Then the speaker told how de-Broglie derived the expression in relation with the momentum and wavelength of the photon. Also he added about the harmonic oscillators in blackbody. Then he turned on the new ideas after that when albert einstein entered into the picture. Einstein used the concept of blackbody in his noble prize winning discovery of Photoelectric effect. About photo electric effect and its mathematical background(F1) prof. Ahluwalia explained the terms like kinetic energy and work function required to eject out electron from the metal surface. And from here the quantum era begins now the different ideas in physics started to emerge out like Neil bohr's hypothesis in atomic physics in which he explained about the distribution of the electrons in the hydrogen atom and explained the spectrum of absorption and emission of radiation. Neil collaborated with his brother Maurice on experiments related to x- rays and the photoelectric effect where he had published his first paper on the underlying quantum theory. Prince Louise de-Broglie had received his Doctoral Degree from the Sorbonne University, in his thesis he enunciated one the great unifying principles in all of physics and he stated: "***I am convinced that the wave-particle duality discovered by einstein in his theory of the light quanta is absolutely general and extends to all of the physical world, and it seems certain to me, therefore , that the propagation of a wave is associated with the of a wave is associated with the motion of a particle of any sort-photon, electron, proton or any other***."

In between Prof. Ahluwalia also mentioned about intuitional discoveries like Hans Cristian Orsted discovered the Magnetic Field around a current carrying conductor, then Michael Faraday just reverse the experiment and placed the moving conductor in

magnetic field and observed the generation of the current in it and called it Law of Electromagnetic Induction.

Prof. Ahluwalia also explained the concepts in quantum mechanics like wave packets, phase and group velocity related to propagation of the light radiation. In very beautiful manner he also explained the basics of Heisenberg's Uncertainty Principle as the relation between the frequency (later taken as momentum) and wavelength (later taken as the position). He explained that if the wavelength is higher then the frequency is low as the momentum and uncertainties in its value and vice versa. Wave-Particle Duality is the greatest milestone in the quantum sciences. Experimental Verification credits goes to G. P. Thomson and Devison and Germer for D-G Experiment. For an electron in an atom, its associated wave is stationary i.e. standing wave, only having certain discrete frequencies which is just Bohr's quantum postulate.

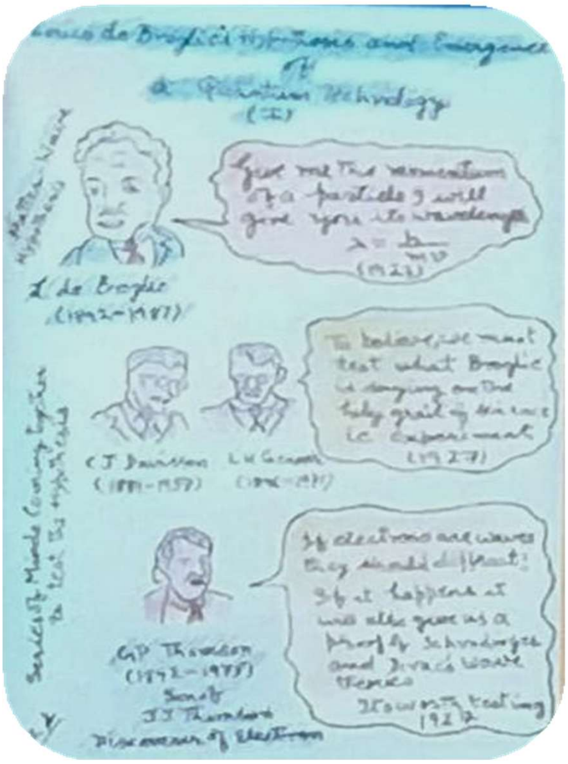
Then Schrodinger came and gave the idea why not develop a wave equation for matter wave? And gave the Wave Mechanics. And that wave mechanics then came to everywhere explaining Then after the completion of doodle presentation interaction session was conducted by Dr Umesh Palikundwar. Then the event came to final stage of head of Department remark given by Dr. O. P. Chimankar. The vote of thanks were proposed by Dr Govind Lakhotiya and the event was concluded with National Anthem.

Available on YOUTUBE https://youtu.be/NpAYs5JYdA4

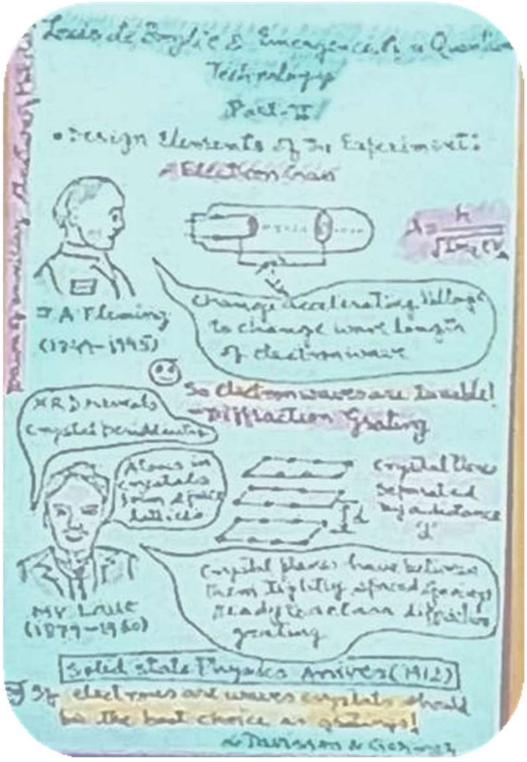
Courtesy: **Mr Roshan Fukat** Student of **M.Sc. Sem II PGTD Physics, RTMNU** helped in compilation of detailed report.

Prof. S. W. Anwane
President
IAPT SRC-08 E

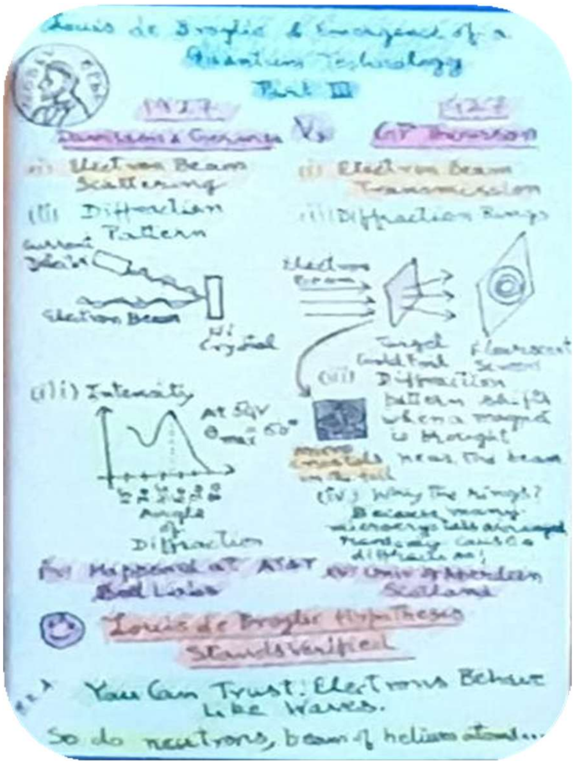
Doodles



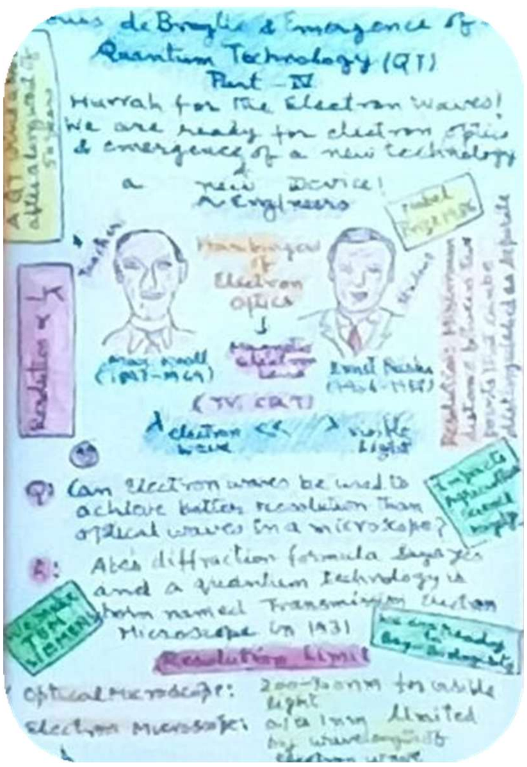
L de Broglie (1892–1987)
C J Davisson
G P Thomson



Technology
Part-II
J A Fleming
M V Laue (1879–1960)
Solid state Physics Arrives (1912)



Louis de Broglie & Emergence of a Quantum Technology
Part III
1927
Vs
GP Thomson
Louis de Broglie Hypothesis Stands Verified
You Can Trust; Electrons Behave Like Waves.

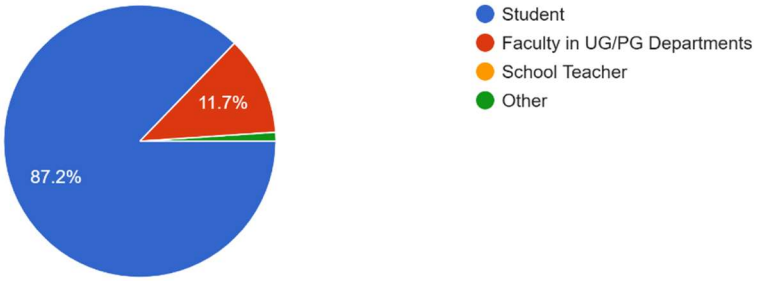


Quantum Technology (QT)
Part - IV
Hurrah for the Electron Waves!
We are ready for electron optics & emergence of a new technology
Q: Can Electron waves be used to achieve better resolution than optical waves in a microscope?
A: Abe's diffraction formula says yes and a quantum technology is born named Transmission Electron Microscope in 1931
Resolution Limit

QUIZ Statistical Analysis from Responses

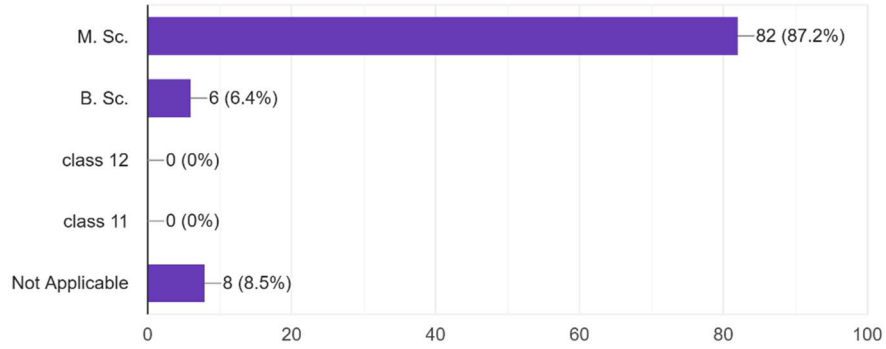
You are a

94 responses



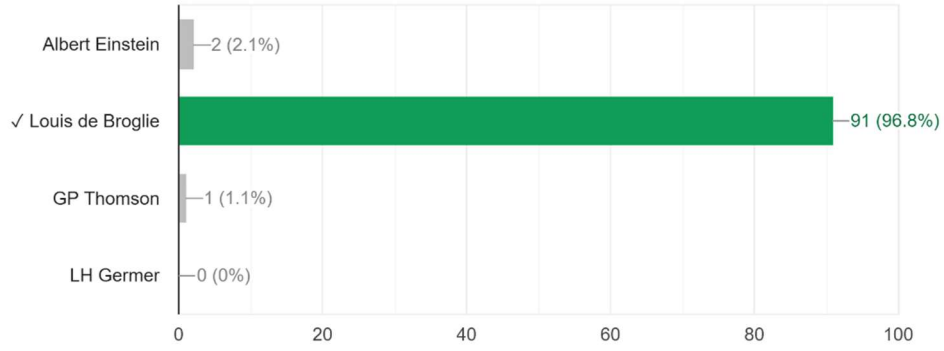
Class in which you are studying, tick one

94 responses



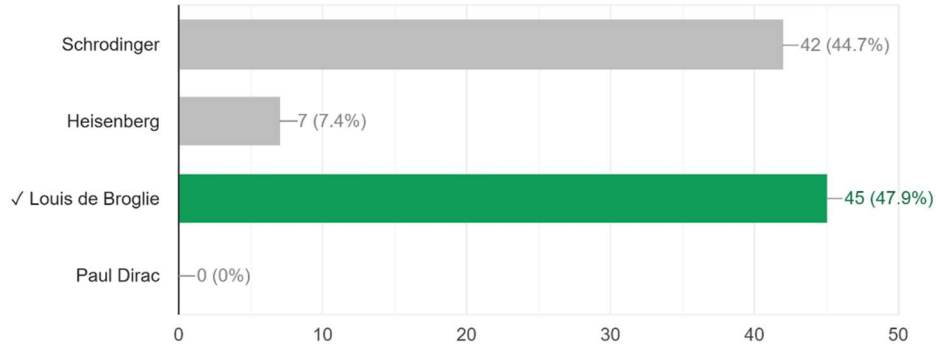
1. Matter Wave hypothesis was proposed by

91 / 94 correct responses



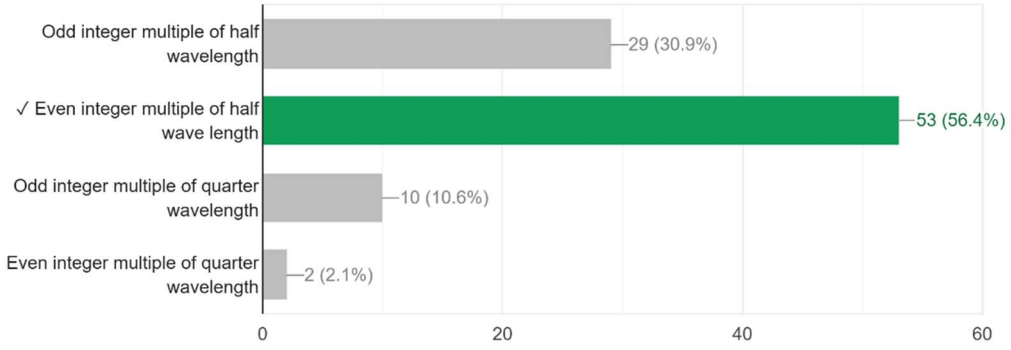
2. Who said let me replace electron orbit by a wave orbit?

45 / 94 correct responses



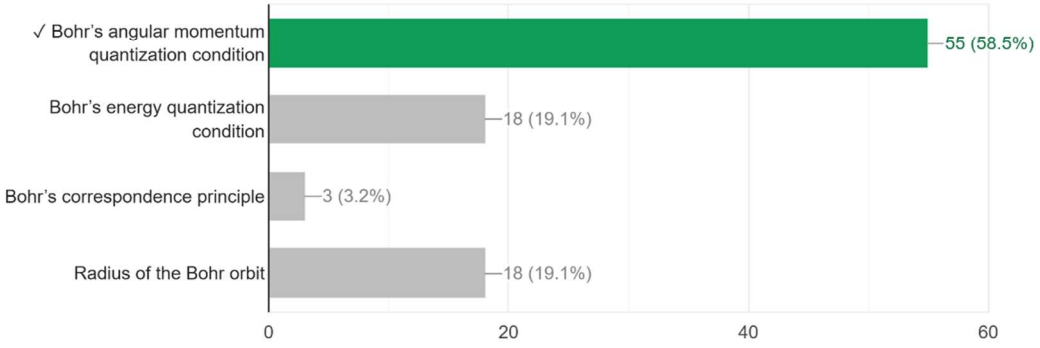
3. How is circumference of an electron orbit in Bohr's orbit is related to the corresponding wavelength of the electron wave?

53 / 94 correct responses



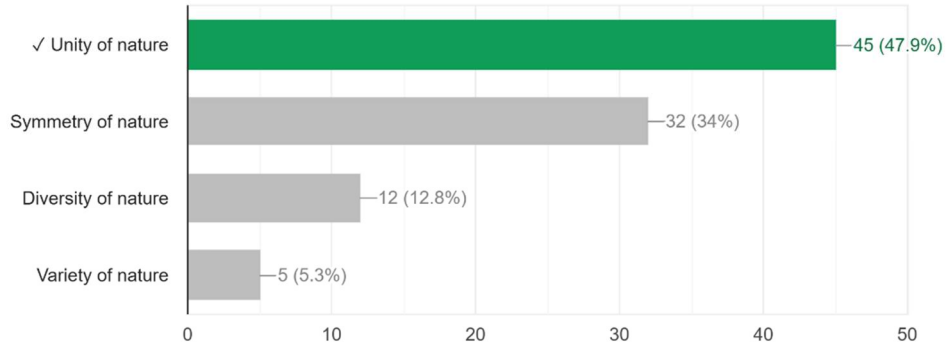
4. One can derive de Broglie formula starting from

55 / 94 correct responses



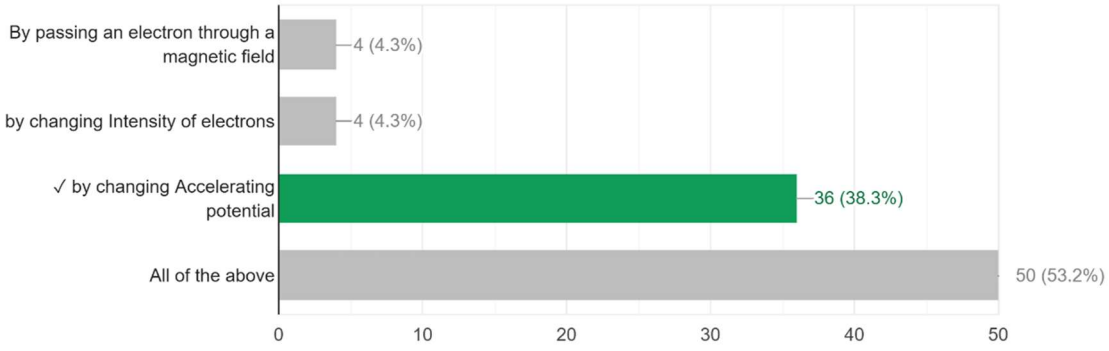
5. Quanta of light and waves of matter signify

45 / 94 correct responses



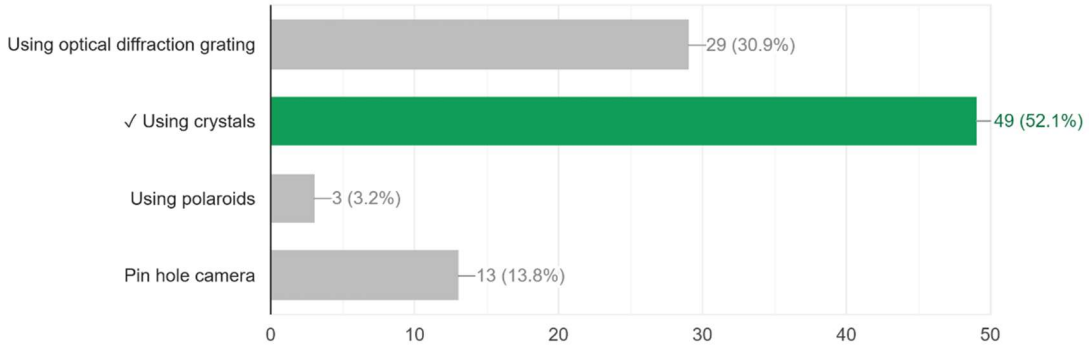
6. Electron wave length can be changed

36 / 94 correct responses



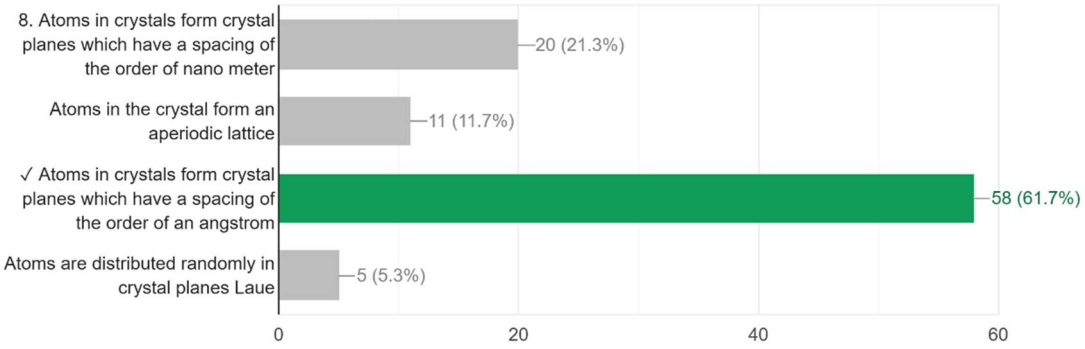
7. To see diffraction of electron wave, most suitable way is by

49 / 94 correct responses



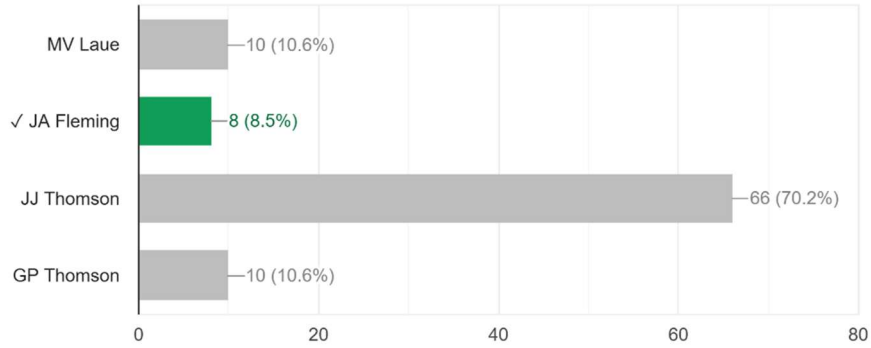
8. X-ray diffraction by crystals reveals that

58 / 94 correct responses



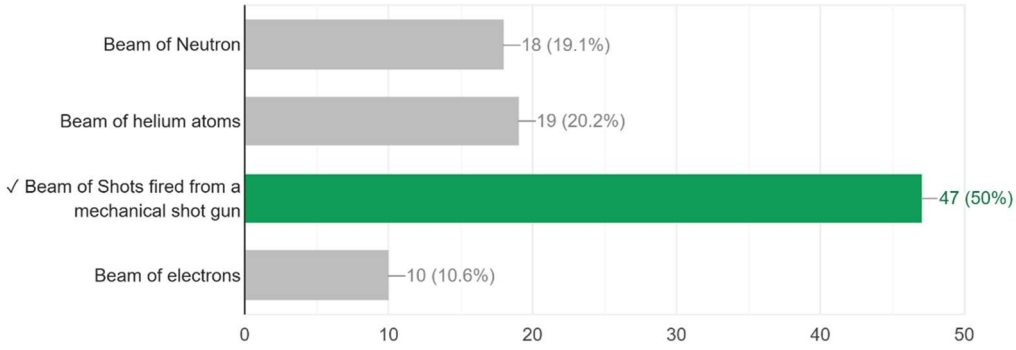
9. Electron gun was invented by

8 / 94 correct responses



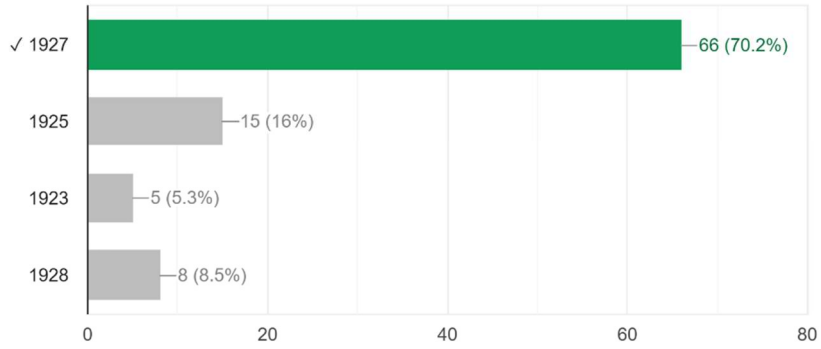
10. Which one of the following objects do not show diffraction using crystals?

47 / 94 correct responses



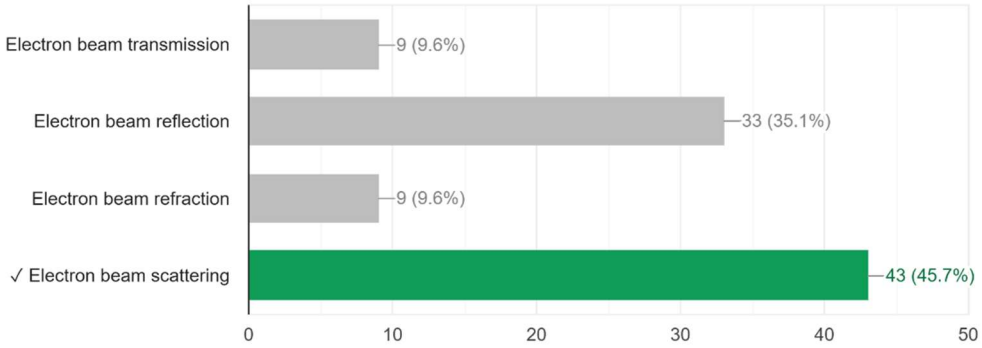
11. When did GP Thomson observe that electrons show diffraction?

66 / 94 correct responses



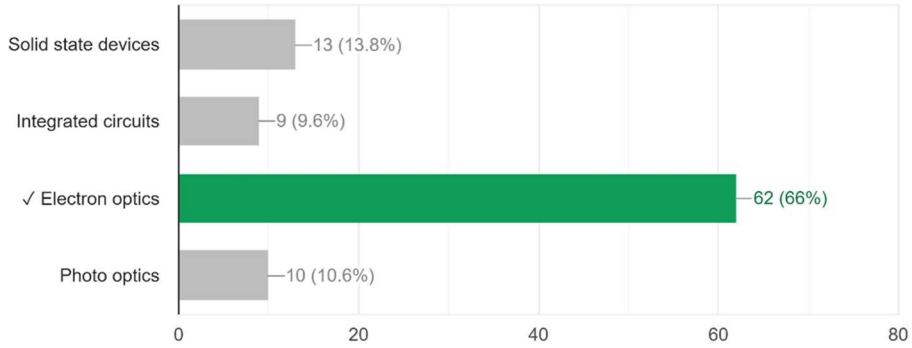
12. Davisson and Germer method to observe electron diffraction involved

43 / 94 correct responses



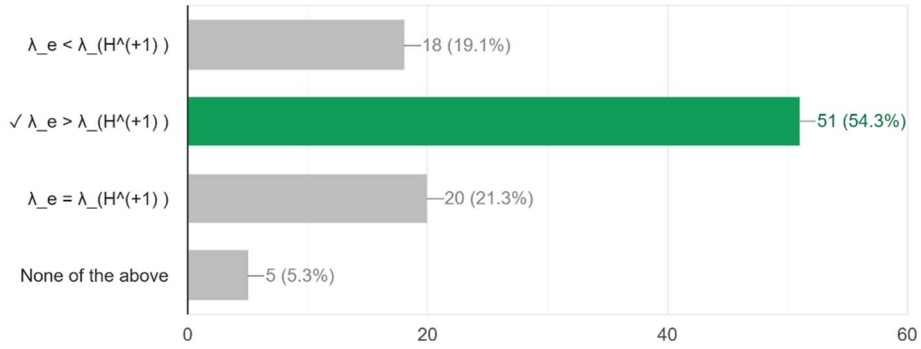
13. What was the technology which emerged because electrons are waves?

62 / 94 correct responses



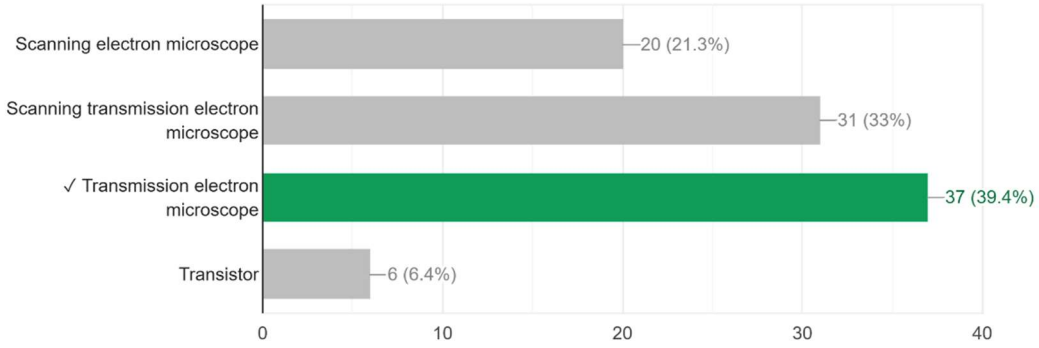
14. Which of the following statements is true for waves of respective particles for the same Transmission accelerating potential?

51 / 94 correct responses



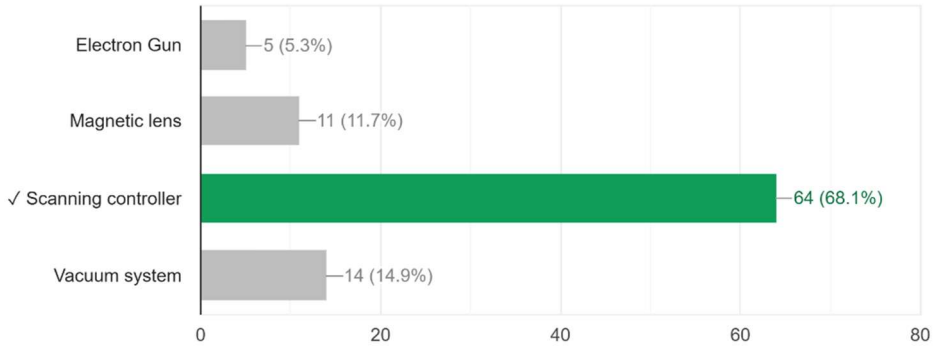
15. Out of the following which was the earliest quantum technology resulting from electron optics?

37 / 94 correct responses



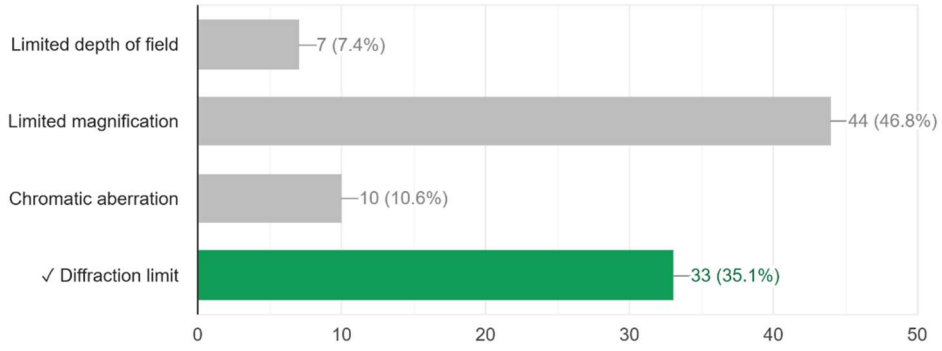
16. Which one of the following is not a component of a transmission electron microscope?

64 / 94 correct responses



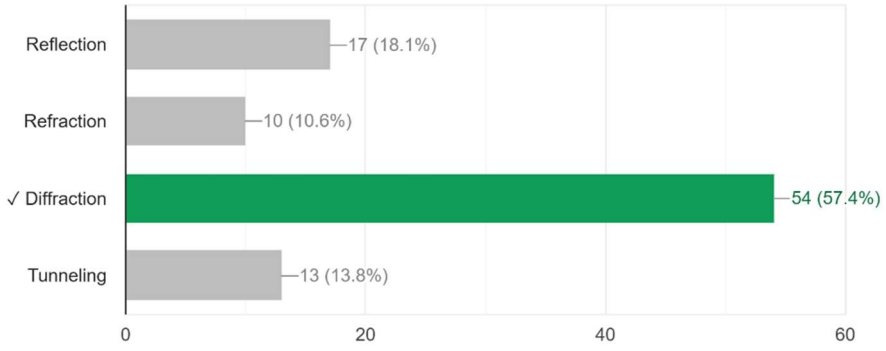
17. What is the main limitation of optical microscopes over the electron microscopes?

33 / 94 correct responses



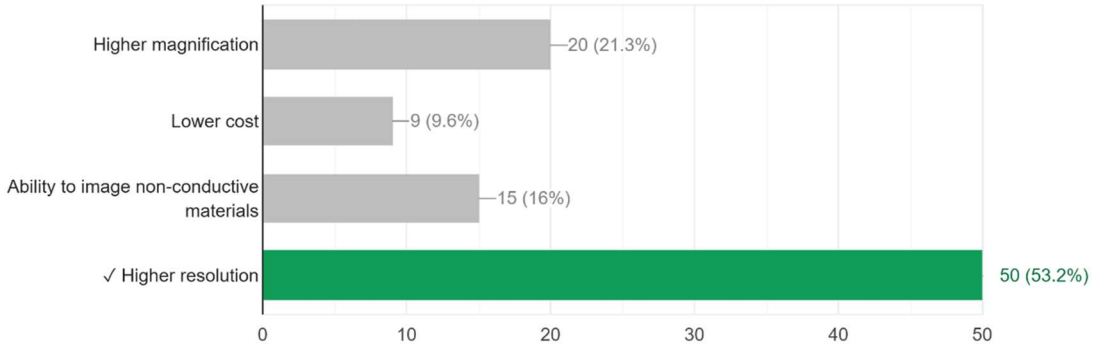
18. What is the principle behind electron microscopes?

54 / 94 correct responses



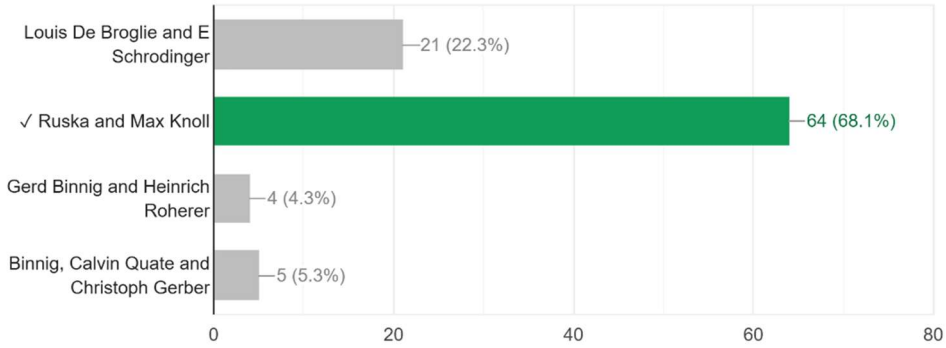
19. What is the primary advantage of electron microscopes over optical microscopes?

50 / 94 correct responses



20. Who were the inventors of Transmission Electron Microscope?

64 / 94 correct responses



Quiz Attendees

Sr No	SCORE	Name
1	18 / 20	Pratiksha Khambadkar
2	18 / 20	Lalima Pramod Misar
3	17 / 20	Trupti Santosh shelke
4	17 / 20	Nikita Ravindra Rajgire
5	17 / 20	Chanda Prakash Jatgade
6	17 / 20	Awez khan
7	16 / 20	Vaidehi Sandip Dawande
8	16 / 20	Pooja solanke
9	16 / 20	SAMIKSHA PRABHAKARRAO KADU
10	16 / 20	Shashank Premnath Yadav
11	16 / 20	Samiksha Suresh Bhange
12	16 / 20	Sachin
13	16 / 20	Meet Digambar katore
14	15 / 20	Rinal Manohar Ganorkar
15	15 / 20	Bharati Gajanan Hadole
16	15 / 20	Hardik S. Kale
17	15 / 20	Nikita Gajanan Khokale
18	15 / 20	Shraddha Vishwas Raut
19	14 / 20	Sakshi Dhote
20	14 / 20	Prachi Sarve
21	14 / 20	Gayatri Ramchandra Latkar
22	14 / 20	Divyani maliye
23	14 / 20	Archana singh
24	14 / 20	Rakhi Nandkishor Gaigole
25	14 / 20	Darshana kmalakar Jadhav
26	13 / 20	Roshan Sanjay Fukat
27	13 / 20	Khushbu singh
28	13 / 20	Kamlesh
29	13 / 20	Vedanti Kawle
30	13 / 20	Swati Raju Hargude
31	13 / 20	Nikhita Ravindra Bhute
32	13 / 20	Gayatri Balkrushna Sahare
33	13 / 20	Ragini Manoj Pagote
34	12 / 20	Sakshi
35	12 / 20	Sakshi ukey
36	12 / 20	Vedang Harihar Kamdi
37	12 / 20	Sapana Moreshwar Raut
38	12 / 20	Sanjivani Anand Gadhave
39	11 / 20	Suraj chinche
40	11 / 20	Dr. Sarang R. Daf
41	11 / 20	Ms. Kanchan Bablesh Jivanapurkar
42	11 / 20	Khushbubhutange
43	11 / 20	Khushi Dnyaneshwar Kalbande

44	11 / 20	Rachna rajput
45	11 / 20	Rohit Raju Shende
46	11 / 20	Mayuri sawalkar
47	11 / 20	Vaishnavi santosh kore
48	11 / 20	Amrapali Vijay Korewar
49	11 / 20	Sahil Tikaram Shende
50	10 / 20	Sakshi kadu
51	10 / 20	Jitu Bharat zagekar
52	10 / 20	Shahin Sayyad
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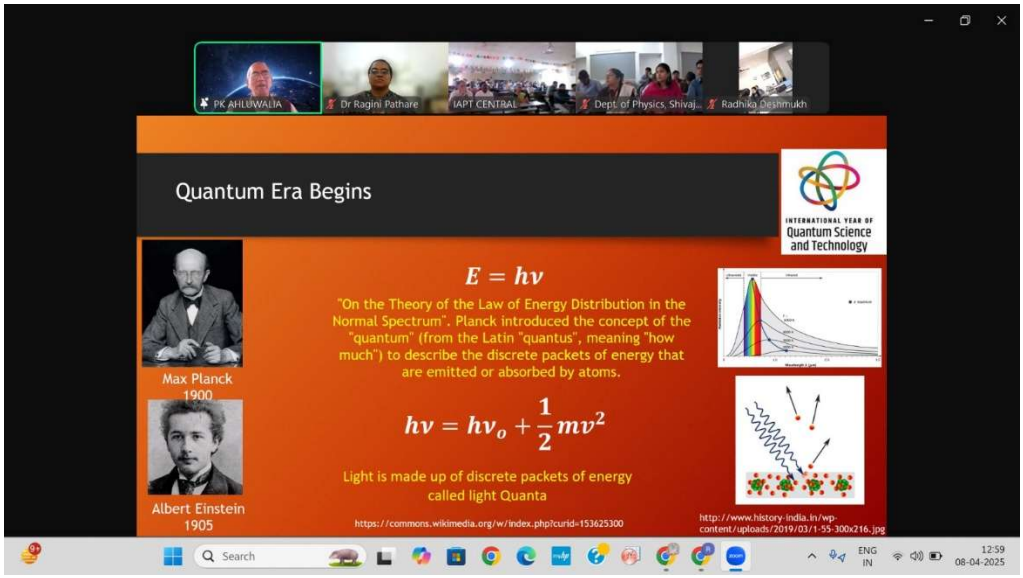
55	10 / 20	nandkishor meshtram
56	10 / 20	Pradnya sambhaji nimgade
57	10 / 20	Drushti Krushna Sidam
58	9 / 20	Dr. Sugandha V. Khangar
59	9 / 20	adiba naz
60	9 / 20	Premkumar kapse
61	8 / 20	Amit Pandey
62	8 / 20	Radhika G Deshmukh
63	8 / 20	Aditi Deshmukh
64	8 / 20	Dhruv Dhoke
65	8 / 20	SIDDHESHWAR M. NAGPURE
66	8 / 20	Shankari Khokaley
67	8 / 20	Shubhangi Anil Nimje
68	8 / 20	Zahabiya Akhtar Shaikh
69	8 / 20	Aishvarya
70	8 / 20	ADITI KULMATE
71	8 / 20	Mokshada Ajayrao Bhagat
72	8 / 20	Paras atram
73	7 / 20	Nakul Deogade
74	7 / 20	Mukesh Turkane
75	7 / 20	Jayesh Borkar
76	7 / 20	Om Deulkar
77	7 / 20	Mahek Mishra
78	7 / 20	Samiksha Sureshrao Irkhede
79	7 / 20	Haridini Dharerao Vidhale
80	6 / 20	Rimzim Shailendra Ujaoney
81	6 / 20	Anushka Arun Chincholkar
82	6 / 20	Dipika Chakole
83	6 / 20	Pranay Kayarkar
84	6 / 20	Manish
85	6 / 20	Dr Gajanan Jadhav
86	5 / 20	Sumitkumar Dilip Pandey
87	5 / 20	ARYAN ANAND GADHAVE

88	5 / 20	Swati Manoj Humane
89	5 / 20	Dnyanesh Mahajan
90	5 / 20	Kuldeep Kumar
91	5 / 20	Chandrakant Bhoyar
92	4 / 20	Komal v. Sawaj
93	4 / 20	Mayank dongre
94	4/25	Dinesh Kabra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Radhika Deshmukh
Quantum Era Begins
INTERNATIONAL YEAR OF Quantum Science and Technology
$E = h\nu$
"On the Theory of the Law of Energy Distribution in the Normal Spectrum". Planck introduced the concept of the "quantum" (from the Latin "quantus", meaning "how much") to describe the discrete packets of energy that are emitted or absorbed by atoms.
Max Planck 1900
$h\nu = h\nu_o + \frac{1}{2}mv^2$
Albert Einstein 1905
Light is made up of discrete packets of energy called light Quanta
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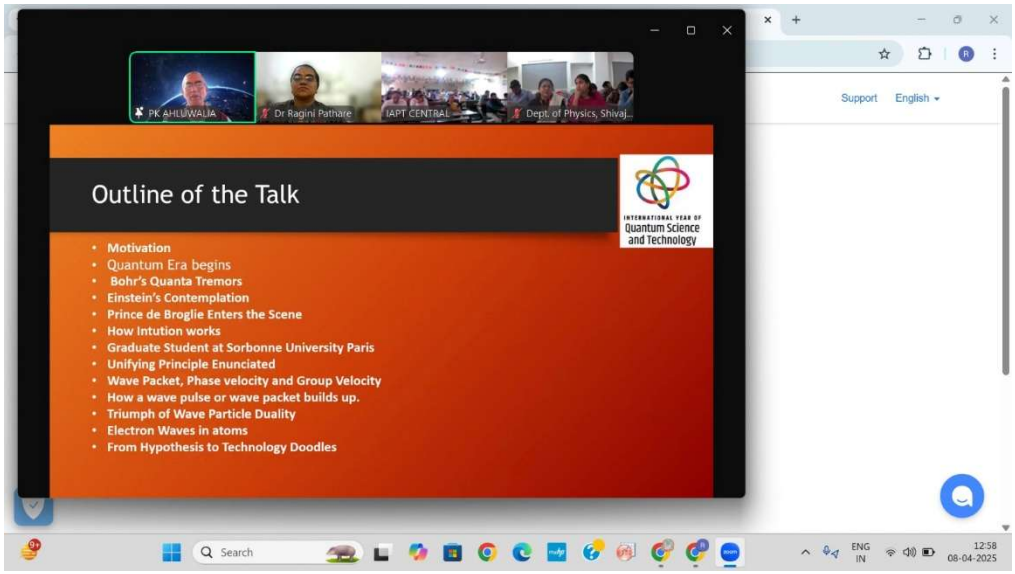
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English
Outline of the Talk
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Motivation
Quantum Era begins
Bohr's Quanta Tremors
Einstein's Contemplation
Prince de Broglie Enters the Scene
How Intution works
Graduate Student at Sorbonne University Paris
Unifying Principle Enunciated
Wave Packet, Phase velocity and Group Velocity
How a wave pulse or wave packet builds up.
Triumph of Wave Particle Duality
Electron Waves in atoms
From Hypothesis to Technology Doodles
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Meeting
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How Intuition Works?
19th century
Hans Christen Orsted's discovery of Magnetic Field around a current carrying conductor(1821)
Michael Faraday's law of electromagnetic induction(1831)
https://en.wikipedia.org/wiki/File:Hans_Christian_Ørsted_daguerreotype.jpg
By Unknown author - [1], Public Domain, https://commons.wikimedia.org/w/index.php?curid=141504840
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