Science & Technology · GS - III

Discuss the work of ‘Bose-Einstein Statistics’ done by Prof. Satyendra Nath Bose and show how it revolutionized the field of Physics.

EXAM YEAR	PAPER	SUBJECT
2018	GS - III	Science & Technology

MARKS	WORD LIMIT
10	~150 words

Answer Hint

Satyendra Nath Bose; quantum statistics; indistinguishable particles; bosons; Planck’s radiation law; Bose–Einstein condensate; modern physics

Model Answer

Introduction

Satyendra Nath Bose was an Indian physicist whose work on quantum statistics fundamentally changed the understanding of particles and radiation. His 1924 paper on radiation statistics was recognised and developed further by Albert Einstein.

Bose–Einstein Statistics

1. **Quantum approach:** Bose derived a new method for counting indistinguishable light quanta, or photons, to explain black-body radiation.
2. **Einstein’s contribution:** Einstein extended the method to material particles, laying the foundation for Bose–Einstein statistics.
3. **Bosons:** The statistics apply to particles with integer spin, such as photons and helium-4 atoms, which can occupy the same quantum state.
4. **Bose–Einstein condensate:** Einstein predicted that, at sufficiently low temperatures, bosonic particles could collectively occupy the lowest energy state. Such condensates were experimentally realised in dilute atomic gases in 1995.

Revolutionary Impact

- Improved the quantum explanation of black-body radiation.
- Helped establish quantum statistical mechanics.
- Explained collective behaviour in systems such as superfluid helium.
- Contributed to the theoretical foundations of lasers, quantum optics and modern condensed-matter physics.
- Established the importance of particle indistinguishability in quantum theory.

Conclusion

Bose’s insight transformed how physicists count and understand quantum particles. The term “boson” honours his lasting contribution to modern physics.

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