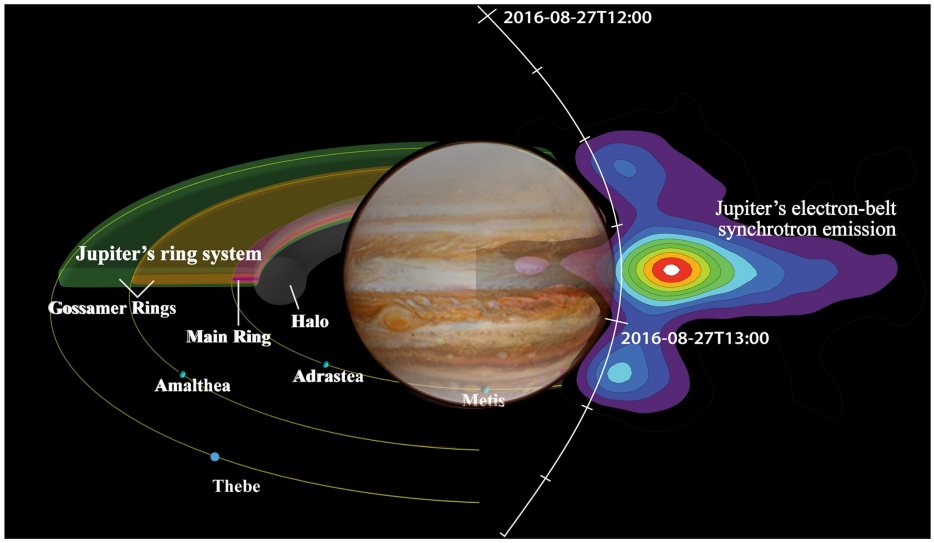
Lecture 16 : Radiation from Accelerated Charges

Electromagnetic radiation is the basis of one of our primary physical senses - that of vision. 'Sensing' in Astronomy, however, is entirely dependent on electromagnetic radiation (except for the new window of gravitational radiation that has opened up in recent years) as we study the distant objects from the radiation emitted (or reflected) across the electromagnetic spectrum.

After Newton, the greatest discovery in physics was the discovery by Maxwell of the differential equations satisfied by the electric and magnetic fields. These equations predicted the existence of electromagnetic waves, as well as the absoluteness of the speed of light. Indeed, the existence of electromagnetic waves was a direct consequence of the constancy of the speed of light. In this lecture, radiation from accelerated charges is discussed, highlighting the essential features of radiation under different astrophysical situations. Like Quantum Statistics and Relativity, this lecture is crucial for understanding the later lectures. After all, all the information we derive about celestial bodies is by analysing the radiation we receive.



Above is a composite image displaying Jupiter's moon and ring system, along with the brightness distribution of the synchrotron radiation in Jupiter's electron belt. Since August 2016, measurements of Jupiter's microwave emissions, ranging from 1.3 cm to 50 cm, have been made with the Juno Microwave Radiometer. The brightness profiles of all the observed frequencies present similarities that can only be explained by the presence of regions of intense synchrotron radiation. [Credit: Santos-Costa et al., 2017, Geophysical Research Letters, 44(17), 8676]

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Astronomy & Astrophysics : An Introductory Survey

A lecture series by Prof. G. Srinivasan

A 'Golden Jubilee Celebration' Event of the Astronomical Society of India

Lecture 16 : Radiation from Accelerated Charges

[Supplementary Material : Dr. Sushan Konar]

Suggested References

This lecture provided a rapid overview of the radiative processes important in the Astrophysical context. For the students to review (or learn) the material in detail, we have compiled a list of textbooks on - a) Classical Electrodynamics, and b) Radiative Processes in Astrophysics. The books are pitched at different levels appropriate for students with different levels of background.

1. Classical Electrodynamics
   (a) R. P. Feynman, 2008, ***The Feynman Lectures, V-II***, Narosa Publishing House https://https://www.feynmanlectures.caltech.edu/
   (b) J. D. Jackson, 1998, ***Classical Electrodynamics***, Wiley
   (c) D. J. Griffiths, 2020, ***Introduction to Electrodynamics***, Cambridge University Press
   (d) L. D. Landau & E. M. Lifshitz, 1975, ***Classical Theory of Fields***, Pergamon Press
2. Radiation in Astrophysics
   (a) G. B. Rybicki & A. P. Lightman, 1985, ***Radiative Processes in Astrophyscs***, Wiley-VCH
   (b) M. Longair, 1992, ***High Energy Astrophysics***, Cabridge University Press
   (c) F. Shu, 2010, ***The Physics of Astrophysics : Radiation***, University Science Books
   (d) W. H. Tucker, 1975, ***Radiation Processes in Astrophysics***, MIT Press

Students may also find the following lectures by Prof. Dipankar Bhattacharya helpful.
Radiative Processes : Dipankar Bhattacharya - Lecture 1, Lecture 2, Lecture 3, Lecture 4

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