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A new explanation for the two breaks in the spectrum of the Crab Nebula.

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Abstract content

The synchrotron spectrum of the Crab Nebula has long been a mystery: rather than having one cooling break, there are at least two breaks: around 1E14 Hz, and around 1E16 Hz. The spectrum cuts off around 1E21 Hz.
The break around 1E14 Hz can be explained by synchrotron cooling, but the second break is rather enigmatic and various explanations have been offered, often involving the presence of two distinct electron populations: a flat spectrum resulting in an undetectable spectral cut-off in the UV, and another, steeper spectrum responsible for the X-ray to MeV gamma-ray spectrum, which also must start somewhere in the absorbed UV band.
Here we explore another possible origin for the break: we assume that a single power-law electron distribution is injected in the nebula, with an intrinsic cut-off around 1E15 eV. We assume that electron energy losses are initially dominated by adiabatic, rather than synchrotron losses, as long as the flow is faster than 0.5c. If the adiabatic cooling is fast enough and the drop in density large, the initial break at 1E15 eV will be shifted to 1 TeV. We show that if the adiabatic cooling results in electron energies scaling as E˜t^(-beta), that the resulting spectral index will be q=1+1/beta, which implies for the Crab nebula beta=0.4
The dominance of adiabatic cooling over synchrotron cooling in the central region of the Crab nebula requires a magnetic field of less than 150 microGauss, consistent with current estimates.

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