X-ray synchrotron emission from loss-steepened electron distributions: applications to shock acceleration in supernova remnants

Stephen P. Reynolds, Jennifer J. Huening (*Physics Department, North Carolina State University*)

Abstract

Several supernova remnants are known to show X-ray synchrotron emission, from electron distributions that are the rolling-off tail of the distributions responsible for radio emission. These electron populations are presumably produced in the remnant blast wave by diffusive shock acceleration. Several mechanisms, escape, finite remnant age or size, or radiative losses, can cause the distribution just downstream of the shock to cut off, probably exponentially. But the distribution will continue to age due to radiative losses as it is convected downstream. If the shock acceleration is very efficient, the initial particle spectrum will not be a power-law but will flatten with energy until at X-ray emitting energies it can be considerably flatter than E^{-2}. If so, the distribution as it moves downstream and ages will develop a sharp cutoff above a maximum energy that drops with time (or with distance behind the shock), and just below that energy there will be a "bump" of electrons initially at higher energies. For sufficiently flat distributions, the "bump" can exceed the extrapolation from lower energies by an order of magnitude. We calculate the synchrotron emissivity of a distribution with such a bump in the specific case of a plane shock with constant downstream density and velocity. An observable feature can serve as a test of the flatness of the electron distribution at the highest energies, which is a general prediction of efficient shock acceleration in nonlinear models.

CATEGORY: SUPERNOVAE, SUPERNOVA REMNANTS AND ISOLATED NEUTRON STARS