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Probing cosmic-ray acceleration efficiency in supernova remnants with X-ray observations

The shape of the observed X-ray spectrum of supernova remnants (SNRs) reflects the interplay between the acceleration and synchrotron cooling of relativistic electrons. It was shown before that under assumption that the maximum electron energy is limited by synchrotron cooling, the cut-off energy of the X-ray spectrum for the known shock velocity provides a direct measure of the Bohm factor which reflects the acceleration efficiency. In this framework, X-ray spectra of non-thermal SNRs with reliable estimates of the age indicate that the Bohm factor is decreasing with time implying that magnetic turbulence is building up as more particles are accelerated. It is important to understand, however, that the maximum energy of electrons may be limited by the age instead of synchrotron cooling, in which case the expected shape of the X-ray spectrum is different as well as the dependence of the cut-off energy on the Bohm factor. In this work we analyse X-ray data from a sample of 10 young SNRs fitting the spectrum with both synchrotron- and age-limiting model. By relaxing the requirement that the cut-off in the X-ray spectrum is limited by synchrotron cooling and applying the appropriate model to each individual SNR taking into account estimates of the magnetic field, we find that the value of the Bohm factor scatters around ˜2-6 with no apparent dependency on the age of the remnant. Our results indicate that the acceleration efficiency does not necessarily depend on the age of the SNR during the first ˜2000 years of evolution, but rather reflects particular conditions of individual SNRs.

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