On Tycho Supernova Remnant Accelerating Cosmic-rays

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Young supernova remnants (YSNRs) are possible sites of cosmic-ray (CR) acceleration, thanks to which the CRs were observed to reach energies as high as 10e15 eV. However, such acceleration can be achieved only if the magnetic fields of these YSNRs were amplified. This process of magnetic field amplification (MFA) has been theoretically described by Bell&Lucek (2001), but has never been proven to be really taking place in remnants. In my work, I analyze thin filaments at the edges of Tycho SNR. There are generally two ways how such filaments could have been formed – thanks to the MFA or thanks to a locally damped magnetic field (MFD). Using formulae of the CR precursor length for both the MFA and the MFD, I derive the dependency of the filament thickness on the SNR's forward shock speed and use this relationship to demonstrate that the filaments are formed due to the MFA. Hence, it is proven that the magnetic field of Tycho is indeed amplified. The MFA nature is then also confirmed by a detailed analysis of the filaments' intensity profiles in both radio and X-ray. Spectral analysis is made in order to find out a value of the forward shock's electron density, and afterwards, the rate of the MFA is calculated. I found that Tycho's magnetic field is amplified to 300(+/-20)uG downstream and that the CRs can achieve energies up to 0.58(+/-0.6)x10e15eV. Therefore, it is demonstrated that Tycho really is a site of the CR acceleration. These values are then used as a new method to specify the still uncertain distance of Tycho SNR, which is found to be 3.1(+/-0.2)kpc.

Awards Won:

First Award of $5,000

European Organization for Nuclear Research-CERN: All expense paid trip to tour CERN