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Very High Energy Gamma Rays from Supernova Remnants and Constraints on the Galactic Interstellar Radiation Field

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Abstract. The large-scale Galactic interstellar radiation field (ISRF) is the result of stellar emission and dust re-processing of starlight. Where the energy density of the ISRF is high (e.g., the Galactic Centre), the dominant γ-ray emission in individual supernova remnants (SNRs), such as G0.9+0.1, may come from inverse Compton (IC) scattering of the ISRF. Several models of the ISRF exist. The most recent one, which has been calculated by us, predicts a significantly higher ISRF than the well-used model of Mathis, Mezger, and Panagia [1]. However, comparison with data is limited to local observations. Based on our current estimate of the ISRF we predict the gamma-ray emission in the SNRs G0.9+0.1 and RXJ1713, and pair-production absorption features above 20 TeV in the spectra of G0.9+0.1, J1713-381, and J1634-472. We discuss how GLAST, along with current and future very high energy instruments, may be able to provide upper bounds on the large-scale ISRF.

Keywords: gamma rays, cosmic rays, diffuse background, interstellar medium, gamma ray telescope
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INTERSTELLAR RADIATION FIELD

The ISRF calculation uses a model for the distribution of stars in the Galaxy, a model for the dust distribution and properties, and a treatment of scattering, absorption, and subsequent re-emission of the stellar light by the dust. A brief description of our calculation is available in [2, 3, 4]; full details will be available in a forthcoming publication [5].

GAMMA-RAY EMISSION FROM SUPERNOVA REMNANTS AND ATTENUATION ON THE ISRF

The evidence for particle acceleration in supernova shells comes from electrons whose synchrotron emission is observed in radio and X-rays. Recent observations by the HESS instrument reveal that supernova remnants (SNRs) also emit TeV γ-rays. We have considered one-zone leptonic models and fitted the multi-wavelength spectra of the supernova remnants (SNRs) G0.9+0.1 and RXJ1713 observed by the HESS [4]. Figure 1 shows our results. For the inner Galaxy, the emission in the GLAST energy range is dominated by IC scattering on the optical and infrared components of the ISRF, while scattering on the CMB dominates the emission toward the outer Galaxy.

We have made a calculation of attenuation of very high energy (VHE) γ-rays in the Galaxy using the new ISRF which takes into account its nonuniform spatial and angular distributions [3]. Figure 2 shows the effect of the attenuation on the ISRF for several HESS sources located at different positions in the Galactic plane. The majority of the attenuation occurs on the infrared component of the ISRF [3].

CONCLUSIONS

The IC emission of individual SNRs can include significant contributions by the ISRF. In the outer Galaxy the emission is predominantly from IC scattering on the cosmic microwave background (CMB). Thus, observations of outer Galaxy SNRs could help determine intrinsic properties for the studied source class. In turn, these could be applied to similar objects in the inner Galaxy. By assuming that the ISRF is the sole target photon field, observations of inner Galaxy SNRs may provide an upper limit on the optical component of the ISRF.

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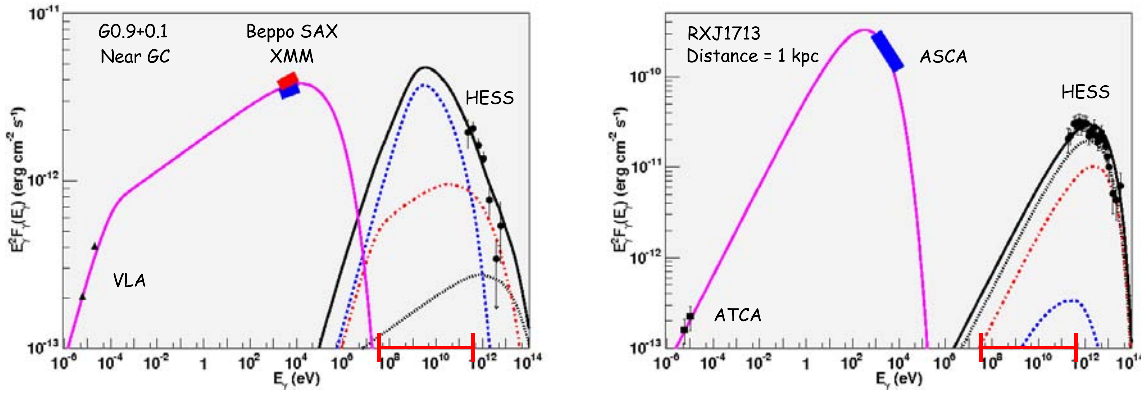

FIGURE 1. *Left:* Flux spectrum of G0.9+0.1. Line-styles: solid, total synchrotron and IC flux; dashed, optical IC; dash-dotted, infra-red IC; dotted, CMB IC. The GLAST energy range is indicated by the barred red line. *Right:* Flux spectrum of RXJ1713. Line-styles as for left panel. Data are summarised in [4].

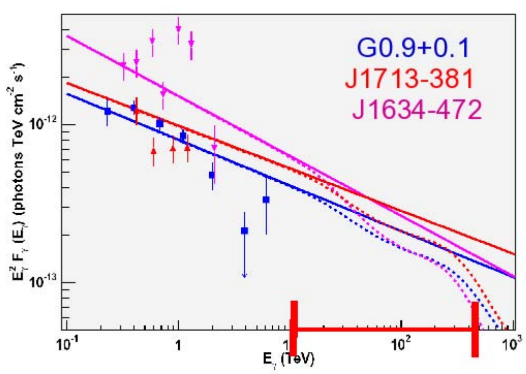

FIGURE 2. Attenuation on the ISRF for in-plane HESS sources. Line-styles: solid line, intrinsic spectrum; dashed line, attenuated spectrum. Data and locations of sources are summarised in [7]. The energy range of future experiments, such as TenTen [6] is indicated by the barred red line.

Future high energy experiments [6] may be able to see features in the VHE spectra of SNRs due to absorption on the infrared component of the ISRF. Non-observation of absorption implies an upper bound on the the ISRF between the source and observer. Indirectly, this contrains the dust emission.

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