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"Far Infrared Observations of Crab-Like Supernova Remnants"

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Final Report

IRAS Guest Investigator Program

"Far Infrared Observations of Crab-Like Supernova Remnants"

Abstract

Using the IRAS data base, we have begun an investigation of the far infrared properties of Crab-like supernova remnants and other synchrotron nebulae. We have examined both the co-added scanning data and, where available, pointed observations. To date we have found infrared emission from two Crab-like remnants: G24.7+0.6 in which the infrared source near the center of the object has been shown to be a compact HII region with EM $\gtrsim 10^7$ pc cm^{-6}; and G0.9+0.1 where a marginal detection of a 25μ source coincident with the remnant core has been used to set limits on the energetics of this synchrotron nebula. Further work, in progress under a second year of this program, should yield additional information concerning the distribution of initial pulsar spin periods and the evolution of synchrotron nebulae.

Under the IRAS Guest Investigator program, we have begun a comprehensive study of the far-infrared properties of Crab-like supernova remnants and other pulsar-driven synchrotron nebulae. The two publications reporting our first results are attached. A preliminary examination of all coadded scanning data has been completed for the two dozen sources listed in the original proposal, and one or two additional detections appear likely. However, since many of the targets were included in the pointed observations program, we held off on a detailed analyses of these until the more sensitive pointed data became available. We have now obtained FITS format tapes of the relevant pointed data and are in the process of analyzing these under a second year of our program funded under the 1986 round of Guest Observer approvals. Many new results are expected to be published during the coming year.

The results described in the attached preprints are exemplary of the type of information on supernova remnants that can be derived from IRAS data. For G24.7+0.6 (Becker and Helfand 1986) the infrared information allowed us to identify the inverted spectrum compact radio source adjacent to the center of this Crab-like remnant as an ultra compact HII region with a calculated emission measure in excess of 10^7 pc cm^{-6}. Several other nearly HII regions are also apparent in both the radio and infrared images. This is the second recently discovered instance of coincident Crab-like remnants and compact HII regions (Becker and Helfand 1985), strengthening the association of the progenitors of such remnants with young massive stars, as well as highlighting the difficulty of distinguishing nonthermal and thermal radio emission in regions of active star formation.

In our second paper resulting from this project (Helfand and Becker 1986), we have claimed a marginal detection of the Crab-like core of the composite remnant G0.9+0.1 at 25 μ. Using this flux (or more conservatively, taking a somewhat higher flux as an upper limit to the far infrared emission) along with the radio and X-ray data available, we can set strong constraints on the energetics of this radio-luminous synchrotron nebula. In particular, we find nebular magnetic field strengths of 0.5 to 1.5×10^{-4} G (a factor of 3-10 lower than for the Crab Nebula) and a total energy content in particles and field of a few $\times\ 10^{47}$ ergs, implying an initial pulsar spin period of $\lesssim$ 10 msec. The extension of results such as these to other synchrotron nebulae in the coming year will provide important new information on the distribution of initial pulsar periods and on the evolution of Crab-like supernova remnants.

References

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