Seeking, Seeing and Studying Isolated Neutron Stars with XMM

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ABSTRACT

Fewer than a dozen supernova remnants in the Galaxy and the Magellanic Clouds contain a detected isolated nuetron star, although we expect that up to 80% of the 275 remnants known have arisen from core collapse supernovae. At most a handful of older isolated neutron star candidates have been found, although we believe at least 100 million exist in the Milky Way. And only 3% of the nearly 1000 radio pulsars catalogued to date have been detected as X-ray sources, despite the fact that we expect most to be warm enough to emit thermal X-rays and many to have the capability of producing nonthermal emission as well. While these statistics may seem modest indeed, they represent an enormous advance over the situation at the beginning of this decade, when many fewer examples of high energy emission from isolated neutron stars were known. Nonetheless, for most examples we have less than a few hundred photons, and the rich diagnostic power in the radiation from the surface of a star (the way we study most stars, after all) remains untapped. XMM will revolutionize this field. With EPIC, we will find neutron stars in dozens more remnants, allowing us to deduce for the first time the initial distributions of neutron star spin rates, magnetic fields, beaming fractions, and velocities. We will also find dozens of older isolated neutron stars as serendipitous sources, providing answers to such questions as the rate of magnetic field decay. For the brightest X-ray emitting pulsars, we will obtain extremely high quality, energy-resolved light curves, allowing quantitative tests of new models for radiative transfer in neutron star atmospheres and the geometry of the surface and magnetospheric fields. And, with RGS, we have the possibility of detecting line features from the X-ray photosphere, fulfilling at last the original promise of thermal X-ray emission – the determination of the mass-radius relation for a neutron star. By seeking new objects young and old, seeing their surfaces, and studying their atmospheric lines, XMM will open a new era in the physics and astronomy of isolated neutron stars.