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Very cool gamma-ray pulsar J1957+5033

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The gamma pulsar J1957 + 5033 has a period of 375 ms, a characteristic age of 840 thousand years, and a rotation energy loss rate of 5e33 erg / s. According to the age, this pulsar can be at the beginning of the photon stage of the neutron star cooling process when according to standard cooling scenarios the surface temperature and thermal luminosity of a star, begin to drop exponentially with time. We present the results of X-ray observations of the pulsar with XMM-Newton. The data show that the thermal spectral component dominates in the low-energy part of its X-ray emission. Its spectral analysis results in a very low surface temperature of the neutron star, less than 30 eV (for a distant observer). This makes this neutron star one of the coldest among known neutron stars, where the thermal component from the entire star surface was found. The estimated bolometric luminosity of the thermal component is rather week and lies in the range 1.4e30 - 1.3e31 erg/s. If we take the characteristic age as an upper limit of the true age, then the low luminosity value can be explained either by direct Urca processes (which requires the star to be massive) or by nucleon superfluidity (which can be used to test modern superfluidity models).

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