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Evidence for a new pulsar wind nebula – Late time X-ray emission from Supernova 1970G

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ABSTRACT

Core-collapse supernovae (SNe) are among the most powerful explosions in the universe that produce neutron stars, black-holes and some gamma-ray bursts. Late-time X-ray observations of SNe can provide important information about the critical phases a massive star evolves through as it approaches core collapse. Here we present new Chandra X-ray Observatory observations of the Type II SN 1970G and compare them with prior observations that had suggested its X-ray luminosity experienced a dramatic re-brightening between 2004-2011 breaking from a previous decades long decline. This unexpected increase could potentially be due to a black hole accreting mass or due to a Pulsar Wind Nebula (PWN). Assuming a distance to the host galaxy M101 of 7.4 Mpc, our 2017 observation shows an X-ray luminosity of (2.34 ± 1.3) x 10^37erg/s that is lower than the 2011 observation (4.1 ± 1.2) x 10^37erg/s but still higher than the 2004 value (1.1 ± 0.2) x 10^37erg/s. Our measurement, therefore, strengthens the argument for a potential new source that might be emitting at a constant X-ray output. The observed X-ray luminosity is higher than that of a typical PWN (10^35 ergs/s), but still consistent with what could be expected from a new PWN, as the pulsar is spinning down. Future monitoring of SN 1970G at radio wavelengths will be crucial to eliminate the possibility of interaction between the supernova's forward blast wave and nearby circumstellar material. Continued X-ray measurements are also required to monitor possible changes in luminosity and to improve spectral fitting.

Keywords: stars: evolution, supernovae: individual (SN 1970G)