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Investigating Superorbital Modulation in the X-ray Binary 4U 1538-52 with the BAT and GBM

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Superorbital periods in Roche-lobe overflowing X-ray binaries such as Her X-1 have been known for some time. These can be understood as being related to the presence of an accretion disk. However, more recently a number of HMXBs accreting from the wind of their supergiant companion, where the presence of a persistent accretion disk is unlikely, have also been found to show superorbital modulation. Swift BAT observations now reveal superorbital modulation in the wind-accreting supergiant high-mass X-ray binary (HMXB) 4U 1538-52 at a period of 14.9130 +/- 0.0026 days that is consistent with four times the 3.73 day orbital period. These periods agree with a previously suggested correlation between superorbital and orbital periods in similar HMXBs. During the ˜14 years of observations the superorbital modulation changes amplitude, and since ˜MJD 57,650 it was no longer detected in the power spectrum, although a peak near the second harmonic of this was present for some time. Measurements of the spin period of the neutron star in the system with the Fermi Gamma-ray Burst Monitor show a long-term spin-down trend which halted towards the end of the light curve, suggesting a connection between dP(spin)/dt and superorbital modulation, as proposed for 2S 0114+650. However, an earlier torque reversal from INTEGRAL observations was not associated with superorbital modulation changes. B and V band photometry from the Las Cumbres Observatory reveals orbital ellipsoidal photometric variability, but no superorbital optical modulation. However the photometry was obtained when the 14.9130 day period was no longer detected in the BAT power spectrum. We consider superorbital modulation mechanisms, and suggest that the Corotating Interaction Region model, with small deviations from orbital synchronization, appears promising. Since the start of 2020 (MJD ˜58,850), 4U 1538-52 has been exhibiting a spin-up trend and we have been monitoring the system to determine whether the superorbital modulation has reappeared.

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