The pulsating magnetosphere of the extremely slowly rotating magnetic beta Cep star xi1 CMa

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Abstract

xi1 CMa is a monoperiodically pulsating, magnetic beta Cep star which is the only known magnetic star to exhibit X-ray pulsations. ESPaDOnS Bz measurements are not compatible with either of the short (_˜days) rotation periods reported in the literature, but rather indicate that P_rot is at least several years long. The star's spectral line profiles can be reproduced with vsini = 0 km/s, consistent with extremely slow rotation. The possibility that the star's Halpha emission might originate around a Be star binary companion is rejected based on constraints on the hypothetical companion's brightness from VLTI AMBER and PIONIER interferometry, in conjunction with upper limits on such a companion's mass obtained via radial velocity residuals after prewhitening with the pulsation frequency. The alternate hypothesis, that the Halpha emission originates within a corotating magnetosphere, is consistent with both the morphology of the emission profile, and with its long-term modulation, which correlates well with Bz. Period analysis of Halpha equivalent widths yields P_rot = 7300 +/- 2000 d (20 +/- 6 yr). The Halpha emission also shows evidence for modulation with the pulsation period. Synthetic spectra modelling the effect of radial pulsation on photospheric line profiles cannot reproduce the amplitude of the pulsational modulation, its phase offset, or the large V/R variations, thus this modulation cannot be explained by variability of the underlying photospheric profile, i.e. it is likely that it reflects changes in the total quantity and distribution of magnetically confined plasma within the circumstellar environment. xi1 CMa is thus the most slowly rotating magnetic B-type star, the only slowly rotating B-type star with a magnetosphere detectable at visual wavelengths, and the only known early-type star whose magnetospheric optical emission is modulated by pulsation as well as rotation.

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