Astronomy and Astrophysics 2017 vol.606

The super-orbital modulation of supergiant high-mass X-ray binaries

Bozzo E., Oskinova L., Lobel A., Hamann W.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© ESO, 2017. The long-term X-ray light curves of classical supergiant X-ray binaries and supergiant fast X-ray transients show relatively similar super-orbital modulations, which are still lacking a sound interpretation. We propose that these modulations are related to the presence of corotating interaction regions (CIRs) known to thread the winds of OB supergiants. To test this hypothesis, we couple the outcomes of three-dimensional (3D) hydrodynamic models for the formation of CIRs in stellar winds with a simplified recipe for the accretion onto a neutron star. The results show that the synthetic X-ray light curves are indeed modulated by the presence of the CIRs. The exact period and amplitude of these modulations depend on a number of parameters governing the hydrodynamic wind models and on the binary orbital configuration. To compare our model predictions with the observations, we apply the 3D wind structure previously shown to well explain the appearance of discrete absorption components in the UV time series of a prototypical B0.5I-type supergiant. Using the orbital parameters of IGRJ 16493-4348, which has the same B0.5I donor spectral type, the period and modulations in the simulated X-ray light curve are similar to the observed ones, thus providing support to our scenario. We propose that the presence of CIRs in donor star winds should be considered in future theoretical and simulation efforts of wind-fed X-ray binaries.

http://dx.doi.org/10.1051/0004-6361/201731930

Keywords

Gamma rays: stars, Stars: massive, Stars: neutron, X-rays: binaries, X-rays: stars

References

[1] Barthelmy, S. D., Barbier, L. M., Cummings, J. R., et al. 2005, Space Sci. Rev., 120, 143
[2] Boggess, A., Carr, F. A., Evans, D. C., et al. 1978, Nature, 275, 372
[3] Bozzo, E., Falanga, M., & Stella, L. 2008, ApJ, 683, 1031
[4] Bozzo, E., Romano, P., Ducci, L., Bernardini, F., & Falanga, M. 2015, Adv. Space Res., 55, 1255
[5] Bozzo, E., Oskinova, L., Feldmeier, A., & Falanga, M. 2016, A&A, 589, A102
[6] Bradt, H. V., Rothschild, R. E., & Swank, J. H. 1993, A&AS, 97, 355
[7] Corbet, R. H. D., & Krimm, H. A. 2013, ApJ, 778, 45
[8] Cranmer, S. R., & Owocki, S. P. 1996, ApJ, 462, 469
[9] Davidson, K., & Ostriker, J. P. 1973, ApJ, 179, 585
[10] Ducci, L., Sidoli, L., & Paizis, A. 2010, MNRAS, 408, 1540

[11] Farrell, S. A., Sood, R. K., O'Neill, P. M., & Dieters, S. 2008, MNRAS, 389, 608
[12] Gehrels, N., Chincarini, G., Giommi, P., et al. 2004, ApJ, 611, 1005
[13] Grebenev, S. A., & Sunyaev, R. A. 2007, Astron. Lett., 33, 149
[14] Hu, C.-P., Chou, Y., Ng, C.-Y., Lin, L. C.-C., & Yen, D. C.-C. 2017, ApJ, 844, 16
[15] Koenigsberger, G., Georgiev, L., Moreno, E., et al. 2006, A&A, 458, 513
[16] Lobel, A., & Blomme, R. 2008, ApJ, 678, 408
[17] Lutovinov, A. A., Revnivtsev, M. G., Tsygankov, S. S., & Krivonos, R. A. 2013, MNRAS, 431, 327
[18] Martínez-Núñez, S., Kretschmar, P., Bozzo, E., et al. 2017, Space Sci. Rev., in press, DOI: 10.1007/s11214-01--0340-1
[19] Massa, D., Prinja, R. K., & Fullerton, A. W. 1995a, ApJ, 452, 842
[20] Massa, D., Fullerton, A. W., Nichols, J. S., et al. 1995b, ApJ, 452, L53
[21] Massa, D., Oskinova, L., Fullerton, A. W., et al. 2014, MNRAS, 441, 2173
[22] Massa, D., & Prinja, R. K. 2015, ApJ, 809, 12
[23] Mullan, D. J. 1984, ApJ, 283, 303
[24] Nazé, Y., Oskinova, L. M., & Gosset, E. 2013, ApJ, 763, 143
[25] Ogilvie, G. I., & Dubus, G. 2001, MNRAS, 320, 485
[26] Oskinova, L. M., Clarke, D., & Pollock, A. M. T. 2001, A&A, 378, L21
[27] Oskinova, L. M., Feldmeier, A., & Kretschmar, P. 2012, MNRAS, 421, 2820
[28] Petterson, J. A. 1975, ApJ, 201, L61
[29] Postnov, K., Shakura, N., Staubert, R., et al. 2013, MNRAS, 435, 1147
[30] Prinja, R. K., & Crowther, P. A. 1998, MNRAS, 300, 828
[31] Puls, J., Vink, J. S., & Najarro, F. 2008, A&ARv, 16, 209
[32] Romano, P., Bozzo, E., Mangano, V., et al. 2015, A&A, 576, L4
[33] Sander, A. A. C., Fürst, F., Kretschmar, P., et al. 2017, A&A, submitted [arXiv:1708.02947]
[34] Shakura, N., Postnov, K., Kochetkova, A., & Hjalmarsdotter, L. 2012, MNRAS, 420, 216
[35] Underhill, A. B. 1975, ApJ, 199, 691
[36] Walter, R., Lutovinov, A. A., Bozzo, E., & Tsygankov, S. S. 2015, A&ARv, 23, 2
[37] Watanabe, S., Sako, M., Ishida, M., et al. 2006, ApJ, 651, 421