High mass X-ray binaries in the galaxy

Saikruba Krishnan, Manjari Bagchi

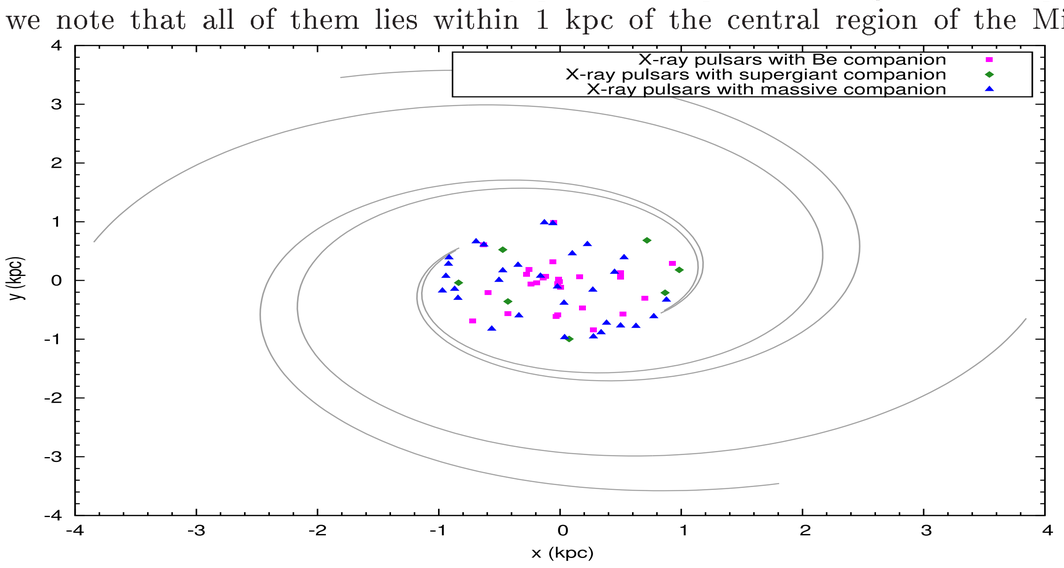
krubakrish@gmail.com, manjari@imsc.res.in

Introduction

- Corbet (1984-1986) investigated the possibility for a correlation to exist between the orbital period and spin period of HMXB having Be star as companion. He proposed two possible relationships (with and without eccentricity) and its validity was studied for Be-HMXB sources known then.
- Many new HMXB binary are found afterwards, with Be companions and other companions. Hence it requires a fresh investigation towards spin period-orbital period correlation of Be-HMXB system.

HMXB population in our galaxy

Milky Way has several spiral arms, each of which is roughly a logarithmic spiral with pitch of about 12 degrees. We use the model of spiral arm structure of the Milky Way used in Faucher et al. (2006), where they use the galactic geocentric system of coordinates. When the X-ray pulsars are plotted along with the spiral arms, we note that all of them lies within 1 kpc of the central region of the Milky Way.



Present work

Two relations between the spin and orbital period suggested by Corbet can be written in the following form-

$$P_s = k_1 P_b^{q_1} \tag{1}$$

with $\boldsymbol{k_1 = 10}$ and $\boldsymbol{q_1 = 0.5}$

$$P_s = k[(1-e)^{3/2} P_b]^q \tag{2}$$

with $\boldsymbol{k = 0.01}$ and $\boldsymbol{q = 2}$
where P_s is spin period, P_b is orbital period, e is eccentricity of orbit, k, q, k_1, q_1 are the fit parameters

We form four sets using the Be-HMXB sources (for which the P_s and P_b values are known) to study the present status of Corbet correlation. PSR B1259-63 is the only γ-ray binary whose orbital period is known.We have used non-linear least-squares estimates of the parameters for the equation using the publicly available statistical analysis package R. We perform the analysis including and excluding the sources SAX J2103.5+4545 and SAX J0635.2+0533, which appears to be outliers (as far from the fitted lines). Correlation coefficients and fit parameters are obtained.

Analysis

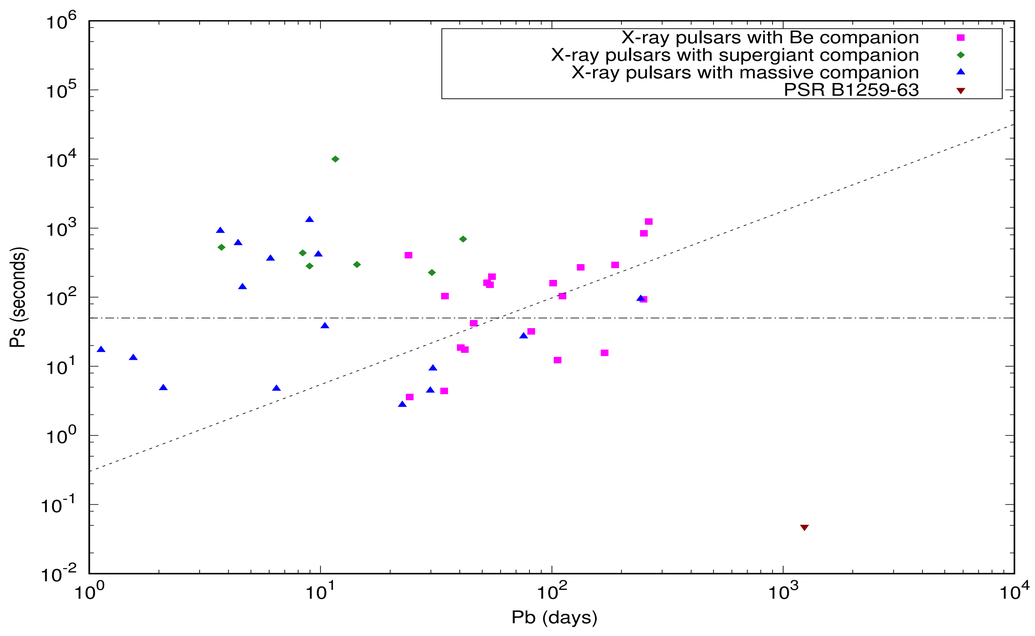
Test of correlation between P_s and P_b, as well as fit parameters for $P_s = k_1 P_b^{q_1}$ relation.

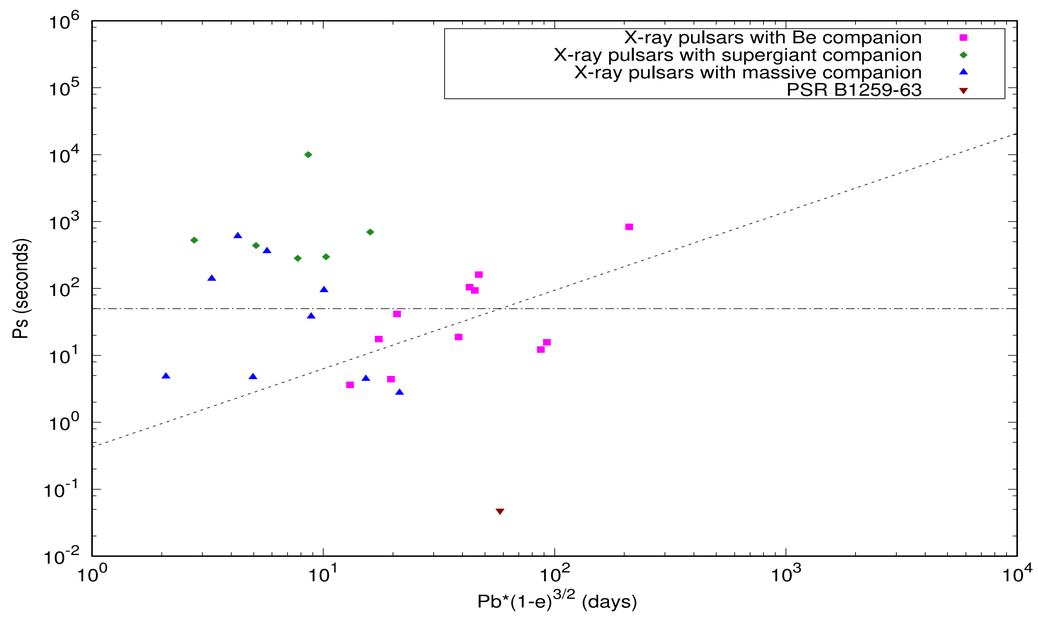
data set	correlation coefficient						fit parameters	
	Pearson		Spearman		Kendall			
	Rp	Pp	Rs	Ps	τ	P_τ	k_1	q_1
22 sources with known values of P_s, P_b	0.5955	0.00345	0.3834	0.0791	0.3247	0.0358	0.2999	1.257
20 sources with known values of P_s, P_b (excluding SAX J0635.2+0533 and SAX J2103.5+4545)	0.6316	0.0028	0.4346	0.0569	0.3579	0.0283	0.9832	0.999
13 sources with known values of P_s, P_b, e	0.5034	0.0795	0.4890	0.0929	0.4103	0.0573	0.0863	1.373
11 sources with known values of P_s, P_b, e (excluding SAX J0635.2+0533 and SAX J2103.5+4545)	0.6343	0.0361	0.6546	0.0338	0.5273	0.0264	0.0561	1.459

Test of correlation between P_s and $P_b(1-e)^{3/2}$, as well as fit parameters for $P_s = k[(1-e)^{3/2} P_b]^q$ relation.

data set	correlation coefficient						fit parameters	
	Pearson		Spearman		Kendall			
	Rp	Pp	Rs	Ps	τ	P_τ	k	q
13 sources with known values of P_s, P_b, e	0.7373	0.00403	0.3462	0.247	0.3333	0.1289	0.4241	1.173
11 sources with known values of P_s, P_b, e (excluding SAX J2103.5+4545 and SAX J0635.2+0533)	0.8706	0.00049	0.5182	0.1069	0.4546	0.0602	0.3208	1.25

Corbet diagram with correlation line drawn using fit parameters obtained for - (i) 22 sources with known values of P_s, P_b (ii) 13 sources with known values of P_s, P_b, e.





Conclusion

This study suggests that the orbital period and spin period appears to have only a moderate correlation and discovery of more Be-HMXB and accurate determination of their orbital parameters will establish whether such a correlation truly exist and if so, then more reliable form of the relationship can be established.

References

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