

Orbital Evolution of the Binary X-ray Pulsar Her X-1

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Abstract. We report the discovery of a break in the orbital period evolution of Her X-1, coincident with a recent anomalous low state.

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1. Introduction

The orbital ephemeris of the binary accreting X-ray pulsar Her X-1 measured during last 30 years deviates from a linear and even from a quadratic function. It can instead be fitted to two different linear functions indicating a sudden change in orbital period. The first such break in the orbital ephemeris was coincident with an anomalous low X-ray state of the pulsar (Deeter et al. 1981, 1991, Still et al. 2001).

Using pulse timing analysis of new archival data from recent X-ray observations with the X-ray observatory Beppo-SAX, we have measured two new mid-eclipse times of Her X-1. These new measurements allow us to understand the orbital evolution characteristics of Her X-1 in greater detail.

2. Observations, Analysis and Results

We have used archival data of the MECS detectors from two Beppo-SAX observations made in 1996 July and 2000 October (Oosterbroek et al. 2001). Small segments of the light curves were folded and pulse profiles were obtained. The pulse profiles show a prominent narrow peak, and a triangular function was fitted to each of the pulse profiles to determine the local pulse arrival times. The resultant pulse arrival time delay curves of the two observations were used to determine the respective mid-eclipse times. The two new mid-eclipse times derived are TDJ = 10288.959090(19) and 11825.910364(25). Following the orbit numbering adopted by Deeter

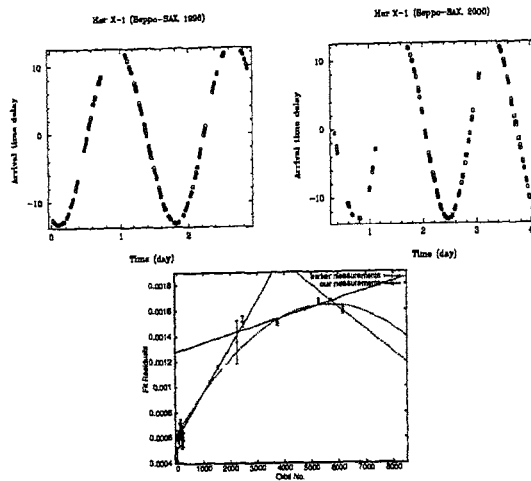


Figure 1. *Top panels* : The pulse arrival time delays of Her X-1, measured from the two Beppo-SAX observations in 1996 and 2000 are shown here. *Bottom panel* : The mid-eclipse time history of Her X-1 is plotted here after subtracting the linear term of the best fitted quadratic function.

et al. (1991), these correspond to orbit numbers 5270 and 6174 respectively. The new mid-eclipse measurements were combined with the past measurements available in literature (Still et al. 2001). The mid-eclipse time history clearly deviates from a linear, a quadratic or two piecewise linear functions.

3. Discussion

The two linear functions used by Deeter et al. (1991) and Still et al. (2001) represent different orbital periods of Her X-1 with a sudden break in between. No explanation is known which may cause such a sudden change in orbital period, except for the fact that the occurrence of this break was coincident with the first anomalous low state of Her X-1. Our new measurement with Beppo-SAX indicates that following the recent anomalous low state, a new break may have appeared in the mid-eclipse time history of Her X-1. However, more measurements after the year 2001 are required to confirm this.

References

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