X-ray Spectral and Temporal Studies of the Ultra-Compact System X1916-05
Final Report (8/15/96 - 2/14/98)

submitted by:

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1 Introduction

This grant supported our analysis of RXTE Cycle 1 data on the ultra-compact low mass x-ray binary (LMXB) X1916-05. In this Final Report, we summarize the Scientific Objectives of this investigation of hard x-ray studies of bursters and the Results Achieved; and finally the Papers PResented, Published (or in preparation).

2 Scientific Objectives of the Research

Our objectives in the study have been to study:

1. *What is the period of the x-ray dips in X1916-05 ?* This period has been previously determined to be about 1% shorter than the accurately measured optical period. A more accurate determination of the dip period is crucial to establish which period (x-ray or optical) is the orbital period of the system.

2. *What is the phase stability of the x-ray dip period ?* And how does the x-ray vs. optical period and phase vary over the ~5 day long-term period previously observed by Ginga?

3. *What is the spectral break energy and its dependence on mass transfer rate ?* By combining PCA and HEXTE spectral data, the hard x-ray spectrum of this LMXB can be measured as a function of m-dot over its long-term (199d) cycle. We shall also investigate spectral changes (at hard energies) in and out of dips to probe the disk and source region.

4. *Are QPOs detected from this LMXB ?* We are analyzing the high time resolution data for QPOs and have presented evidence for their discovery from this source.

3 Results Achieved

Considerable progress was achieved over the duration of this grant in measuring the x-ray dip period and its phase stability. Preliminary results (presented at the HEAD meeting in November, 1997) show that the x-ray dip period is 3000.592 $\pm$0.005 sec with a scatter of only $\sim$0.2 in dip phase over the full 8 month interval of the cycle 1 data. This indicates the dip period may be indeed as stable as the optical period and thus could be the binary period. This would make X1916 similar to the other dip sources, where the longer (in this case, the optical) period is driven by disk precession due to the eccentricity induced in the disk by the companion star.

However, this conclusion is still not final (work is in progress) since this would require the dip period ephemeris could be extended back to Ginga (and Einstein) data if it is indeed stable and the binary period. It is already clear that at least one clock in the system is not understood: the expected beat between the x-ray dip and optical periods (both now accurately measured) should be 3.9004 days, but instead a modulation of the phase of the x-ray dip period of about 4.71 $\pm$0.14 days is detected. We are presently working on trying to understand the origin of this modulation period.

Similarly, the spectral analysis has been productive but is also not yet finished. During our May, 1996, series of observations at closer time intervals we were able to track the spectral evolution of the source over a range in flux of a factor of $\sim$2 (from 5.7×10^{-10} to 1.1×10^{-9} erg cm^{-2} s^{-1}). The power law spectral best fit stayed approximately constant (at 2.0) while the best-fit cutoff energy (modelled as a simple exponential cutoff) increased from 11.4 to 27 keV. HEXTE data are now being fit to actually derive a measured value.

Finally, we have also been actively conducting analysis of the data set for QPOs and have detected kHz QPOs at a range of frequencies $\sim$800-1000 Hz as well as also a possible 600 Hz QPO (Barret et al 1997, IAUC 6793). Results are being prepared for publication.

4 Papers Presented, Published or in Progress

Two poster papers have been given on the results of this work thus far, and one IAUC has been published. Two other papers are now in preparation which will report the x-ray dip

period and spectral measurements, respectively, and one paper is in preparation to report the QPO results:

1. "RXTE Study of the Ultra-Compact Dipper X1916-05", (J. Grindlay, P. Bloser, Y. Chou, D. Barret, A. Smale, and J. Swank), poster at HEAD Meeting, Estes Park, CO (Nov. 1997).

2. "RXTE Studies of Hard X-ray Spectra of Ultra-Compact LMXBs", (P. Bloser, Y. Chou, J. Grindlay, T. Narita, and D. Barret), BAAS, vol. 29, no. 5, 1387 (197).

3. "QPOs from 4U1915-05" (D. Barret et al), IAUC No. 6793 (1997).

4. "X-ray Dips and Clocks in X1916-05" (Y. Chou, J. Grindlay, P. Bloser, A. Smale and J. Swank), ApJ, in preparation (1998).

5. "Spectral Variability in X1916-05" (P. Bloser, Y. Chou, J. Grindlay, A. Smale and J. Swank), ApJ, in preparation (1998).

6. "Discovery of QPOs in X1916-05" (D. Barret et al), A&A, in preparation (1998).