

National Aeronautics and Space Administration

FINAL TECHNICAL REPORT FOR NAG 5-3799

Submitted to: Dr. Jay P. Norris, Code 660.1
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

Submitted by: The Trustees of Columbia University
in the City of New York
351 Eng. Terrace
New York, New York 10027

Prepared by: Columbia Astrophysics Laboratory
Departments of Astronomy and Physics
Columbia University
550 West 120th Street, MC-5247
New York, New York 10027

Administrative P.I.: Jules P. Halpern

Science P.I.: Philip Kaaret

Titles of Research: "X-Ray Transients in Star-Forming Regions" and
"Hard X-Ray Emission from X-Ray Bursters"

Report Period: 1 December 1996 - 30 November 1998

Final Technical Report for NASA project NAG5-3799:

“X-ray Transients in Star-forming Regions”

This grant funded work on the analysis of data obtained with the Burst and Transient Experiment (BATSE) on the Compton Gamma-Ray Observatory. The goal of the work was to search for hard x-ray transients in star forming regions using the all-sky hard x-ray monitoring capability of BATSE.

Our initial work lead to the discovery of a hard x-ray transient, GRO J1849-03 (see Zhang, S. N. et al. 1996, A&AS, 120, 227). Follow-up observations of this source made with the Wide Field Camera on BeppoSAX showed that the source should be identified with the previously known x-ray pulsar GS 1843-02 which itself is identified with the x-ray source X1845-024 originally discovered with the SAS-3 satellite. Our identification of the source and measurement of the outburst recurrence time, lead to the identification of the source as a Be/X-ray binary with a spin period of 94.8 s and an orbital period of 241 days. These results were published in Soffitta, P. et al. 1998, ApJ, 494, L203.

The funding was used primarily for partial salary and travel support for John Tomsick, then a graduate student at Columbia University. John Tomsick, now Dr. Tomsick, received his Ph.D. from Columbia University in July 1999, based partially on results obtained under this investigation. He is now a postdoctoral research scientist at the University of California, San Diego.

Publication:

“Identification of the Periodic Hard X-Ray Transient GRO J1849-03 with the X-Ray Pulsar GS -1843-02 = X1845-024: A New Be/X-Ray Binary”, P. Soffitta, J.A. Tomsick, B.A. Harmon, E. Costa, E.C. Ford, M. Tavani, S.N. Zhang, and P. Kaaret, *Astrophysical Journal Letters* v.494, p. L203 (1998).

* * *

“Hard X-Ray Emissions from X-Ray Bursters”

The scientific goal of this project was to monitor a selected sample of x-ray bursters using data from the Burst and Transient Source Experiment (BATSE) on the Compton Gamma-Ray Observatory to characterize the hard x-ray emission of these objects over long time intervals. The project was closely related to “Monitoring x-ray emission from x-ray bursters”, NASA project NAG5-3595, “Hard x-ray emission of x-ray bursters”. NASA project NAG5-4633, and “Long-Term Hard X-Ray Monitoring of X-Ray Bursters”, NASA project NAG5-3891. It shares publications in common with these. These efforts have lead to results directly from the BATSE data and also from Target of Opportunity Observations (TOO) made with the Rossi X-Ray Timing Explorer based on detection of transient hard x-ray outbursts with BATSE. The following papers have used BATSE data or data obtained with BATSE TOO triggers.

Publications:

- “Correlation between Fast Quasi-Periodic Oscillations and X-Ray Spectral Shape in Atoll Sources”, P. Kaaret, W. Yu, E.C. Ford, and S.N. Zhang, *Astrophys. J. Letters* 497, L93 (1998).
- “Discovery of Kilohertz QPOs in the Atoll X-Ray Binary 4U 1705-44”, E.C. Ford, M. van der Klis, and P. Kaaret, *Astrophys. J. Letters* 498, L41 (1998).
- “Measurement of Hard Lags and Coherences in the X-Ray Flux of Accreting Neutron Stars and Comparison with Accreting Black Holes ”, E.C. Ford, M. van der Klis, M. Mendez, J. van Paradijs, and P. Kaaret, *Astrophys. J. Letters* 512, L31 (1999).