



# Time-Frequency Analysis of Superorbital Modulation of X-ray Binary SMC X-1 by Hilbert-Huang Transform

Chin-Ping Hu, Yi Chou, Ming-Chya Wu, Ting-Chang Yang, Yi-Hao Su

(Submitted on 26 Jul 2011)

The high-mass X-ray binary (HMXB) SMC X-1 exhibits a superorbital modulation with a dramatically varying period ranging between  $\sim 40$  d and  $\sim 60$  d. This research studies the time-frequency properties of the superorbital modulation of SMC X-1 based on the observations made by the All-Sky Monitor (ASM) onboard the Rossi X-ray Timing Explorer (RXTE). We analyzed the entire ASM database collected since 1996. The Hilbert-Huang Transform (HHT), developed for non-stationary and nonlinear time series analysis, was adopted to derive the instantaneous superorbital frequency. The resultant Hilbert spectrum is consistent with the dynamic power spectrum while it shows more detailed information in both the time and frequency domains. The RXTE observations manifest that the superorbital modulation period was mostly between  $\sim 50$  d and  $\sim 65$  d, whenas it changed to  $\sim 45$  d around MJD 50,800 and MJD 54,000. Our analysis further indicates that the instantaneous frequency changed in a time scale of hundreds of days between  $\sim$ MJD 51,500 and  $\sim$ MJD 53,500. Based on the instantaneous phase defined by HHT, we folded the ASM light curve to derive a superorbital profile, from which an asymmetric feature and a low state with barely any X-ray emissions (lasting for  $\sim 0.3$  cycles) were observed. We also calculated the correlation between the mean period and the amplitude of the superorbital modulation. The result is similar to the recently discovered relationship between the superorbital cycle length and the mean X-ray flux for Her X-1.

Comments: 26 pages, 9 figures, accepted for publication in The Astrophysical Journal

Subjects: **High Energy Astrophysical Phenomena (astro-ph.HE)**

Cite as: [arXiv:1107.5143](#) [astro-ph.HE]

(or [arXiv:1107.5143v1](#) [astro-ph.HE] for this version)

## Download:

- [PDF](#)
- [PostScript](#)
- [Other formats](#)

Current browse context:

astro-ph.HE

[< prev](#) | [next >](#)

[new](#) | [recent](#) | [1107](#)

Change to browse by:

astro-ph

## References & Citations

- [INSPIRE HEP](#)  
([refers to](#) | [cited by](#))
- [NASA ADS](#)

Bookmark([what is this?](#))



From: Chin-Ping Hu [[view email](#)]

[v1] Tue, 26 Jul 2011 09:31:07 GMT (707kb)

*[Which authors of this paper are endorsers?](#)*

Link back to: [arXiv](#), [form interface](#), [contact](#).