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# Lag variability of GRS 1915+105 during Plateau States

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**Abstract.** The evolution of Time-lags are correlated with the accretion geometry during Plateau states of GRS 1915+105. We find that the lag spectrum for the $\chi_3$ class is different from that of $\chi_1$, $\chi_2$ and $\chi_4$ classes. Hard lags occur only when Comptonizing efficiency (CE) $\geq$ 0.9% for different plateau states and its evolution confirm the sequence of class transitions suggested on the basis of CE parameter. We concluded the variation of time lags could be due to the movement of CENBOL.

*Keywords* : black hole physics – accretion discs – X-rays: binaries – radiative transfer

## 1. Introduction

Galactic microquasar GRS 1915+105 exhibits fast variability during class transitions and at least seventeen types of variability classes are observed (Pal et al. 2013). The energy dependent time-lag and QPO frequency variation is reported for black hole candidates (Reig et al. 2000; Cui et al. 2000; Dutta 2013; Dutta et al. 2013). We present a study of time lags and Quasi Periodic Oscillations (QPOs) for these classes. We calculate time-lag behavior of GRS 1915+105 during its Plateau states.

## 2. Result and Discussion

We analyzed two plateau states of GRS 1915+105 using RXTE Archival data for the period of Plateau-1 (MJD 50260-50320) and Plateau-2 (MJD 50720-50760) (Pal et al. 2015). The energy dependent time-lag and QPO frequency variation is reported for black hole candidates (Reig et al. 2000; Cui et al. 2000; Dutta 2013; Dutta et al. 2013). Fig. 1 shows the correlation between the time lag and QPO frequency for two different energy bands to be similar to other high inclination sources (Reig et al. 2000; Cui et al. 2000; Dutta 2013; Pal et al. 2015). Fig. 2 shows that when CE crosses a certain

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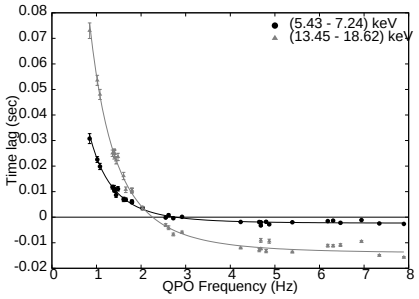


**Figure 1.** Time lag variation with QPO frequencies for different energy band photons w.r.t 2.0-5.0 keV energy band photons during Plateau-2. Black dots represent time lag of 5.43-7.24 keV energy band photons. Gray triangles show time lag of 13.45 - 18.62 keV energy band photons The fitted curves represent the time lag cross over at 2.77 Hz and 2.26 Hz respectively.

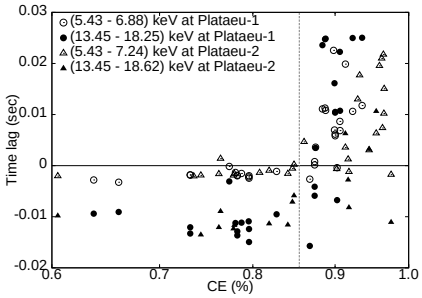


**Figure 2.** Empty circle and solid circle show the Time lags(s) variation with CE (%) for (5.43-6.88) keV and (13.45-18.25) keV energy band photons respectively w.r.t (2.0-5.0) keV energy band photons during Plateau-1 period. Empty triangle and solid triangle are the same for Plateau-2 period.

limit (i.e., CE $\geq$ 0.9%) then only hard lags for both Plateau states (Pal et al. 2013, 2015) are seen. Different physical mechanisms, e.g., Comptonization (always hard lags), Reflection (soft lag effective for high inclination sources), Focusing (soft lag) and Geometry (Reverberation mapping, soft and hard lag) are involved in producing the lags at different Fourier frequencies (Poutanen 2001). This complex pattern of the time lag has resemblance to that observed in high inclination sources (XTE J1550-564, GRO J1655-40 and XTE J1859+226). However, for low inclination sources (GX 339-4, for 2002, 2004, 2007 and 2010 outbursts and XTE J1650-500, for 2001 Outbursts) we always find hard lags which suggest the movement of CENBOL during various class transitions.

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