Microquasar IGR J17091-3624 - artistic view

Figure: http://chandra.harvard.edu/photo/2012/igr/

Microquasar IGR J17091-3624

Heartbeat at the period between 5 and 70 seconds - possible by pressure radiation instability
- Moderately bright transient X-ray binary
- Peak flux level at 20 mCrab in the range 20 – 100 keV
- Discovered by INTEGRAL/IBIS in 2003 (Kuulkers et. al. Astron. Telegram. 149)
- Was searched in archival data of previous missions (TTM-Kvant,BeppoSAX)
- At the end of January 2011 Swift/BAT reported renewed activity of IGR J17091-3624. We started a long monitoring campaign
- 2011 outbursts increased to 120 mCrab
- IGR-J17091-3624 presents fast and ionized wind observed during the soft spectral state
- Simultaneous observations of IGR J17091-3624 with Chandra and RXTE show the presence of wind during some of the heartbeat states

Observational data

Obtaining the data:
- SWIFT mission
- X-Ray data from thermal radiation of the disk - XRT
- 0.2 – 10 keV
- HEASOFT - High Energy Astrophysics SOFTware v.6.15
- XRT pipeline
- XSELECT extracting

Model with and without wind

Model with and without wind
- $M = 3.5 \times 10^{38}$
- Accretion rate between 0.04 and 0.1 Eddington
- Amplitude (maximal luminosity / minimal luminosity) below 9
- Wind parameter change period and range of outbursts significantly

Radiation pressure instability

\[
\frac{\partial P}{\partial r} = 0 \quad (1)
\]

\[
\frac{\partial P}{\partial r} = 0 \quad (2)
\]

The greater the accretion rate the larger is the size of unstable region in disk

Radiation pressure instability

\[
The radiation pressure $P$ is given by the Equation (1)
\]

The radiation pressure $P$ is given by the Equation (2)

1. Theory of outbursts - hydrodynamics

\[
\frac{\partial M}{\partial t} = 0 \quad (3)
\]

\[
M = \frac{\partial E}{\partial r} \quad (4)
\]

\[
\frac{\partial M}{\partial t} = \partial E/\partial r \quad (5)
\]

\[
\frac{\partial M}{\partial t} = \frac{\partial E}{\partial r} \quad (6)
\]

\[
\frac{\partial M}{\partial t} = \frac{\partial E}{\partial r} \quad (7)
\]

\[
\frac{\partial M}{\partial t} = \frac{\partial E}{\partial r} \quad (8)
\]

\[
\frac{\partial M}{\partial t} = \frac{\partial E}{\partial r} \quad (9)
\]

Wind model

The wind mass flow rate is calculated in the spectral coordinate equal to the ratio of the mass of the newly generated gas to the accretion disk, with a fraction determined by $f_{wind}$ to the energy change per particle. $m_{w} = f_{wind} - \frac{\partial E}{\partial m_C}$. We define $m_{w}$ as the kinetic energy in the disk

\[
\frac{\partial M}{\partial t} = \frac{\partial E}{\partial r} \quad (10)
\]

We assume $f_{wind}$ as a simple smooth rational function:

\[
\frac{\partial M}{\partial t} = \frac{1}{1 + A \times \frac{m_{w}}{m_{C}}} \quad (11)
\]

We assume that the relationship holds also in the hydrodynamical computations.

Spectral modeling

Figure: Fe lines in X-ray spectrum, Fe lines in X-ray spectrum (King et al. 2012)

- From the spectral modeling we have column density $0.475 \times 10^{22}$ to $1.14 \times 10^{22}$ cm$^{-2}$
- We can compute column density of wind from our model

Results of the wind disk model, for assumed parameter $A = 15$

$M = 6.3 \times 10^{34}$, $R_{max} = 1000 R_{sun}$

Between the outbursts

\[
\frac{\partial M}{\partial t} = \frac{1}{1 + A \times \frac{m_{w}}{m_{C}}} \quad (12)
\]