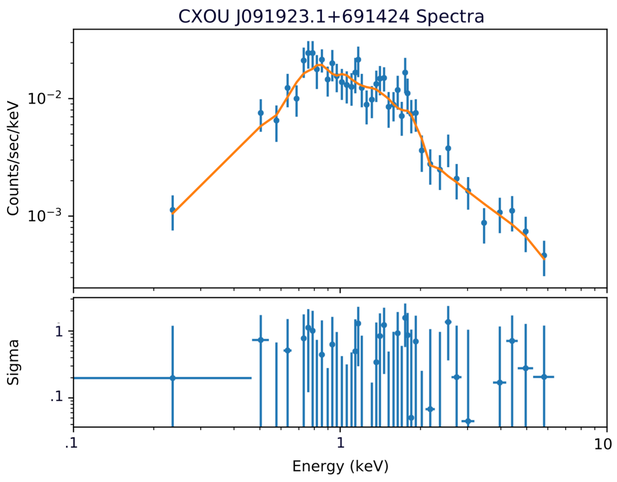
Investigating ACIS spectra of X-ray binaries in archival *Chandra* data

Seth Larner, Roy Kilgard

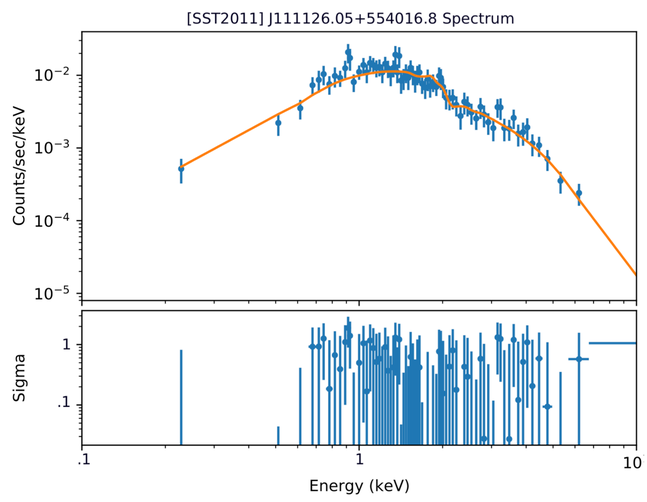
Department of Astronomy, Van Vleck Observatory

Wesleyan University, Middletown, CT

Spectral Fitting



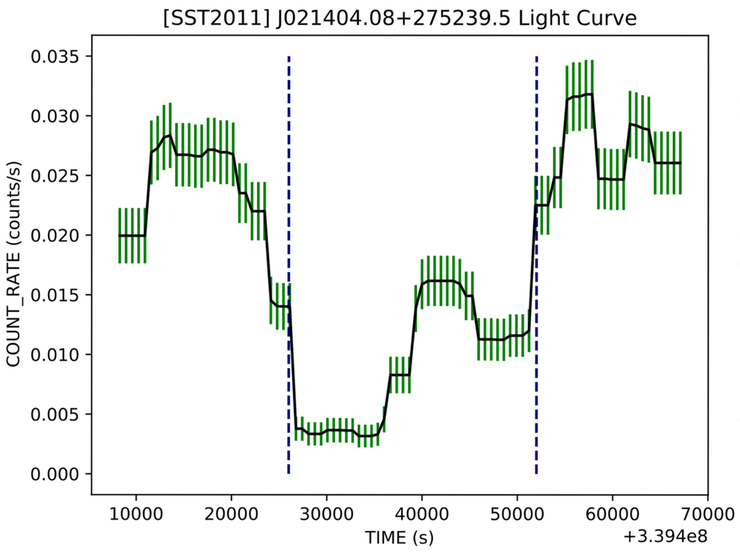
-This source is located in a pair of galaxies called [T2015] nest 102270, located 35 million light years away.
-This source was fit with a power law model, a model for an accreting disk, and a model for hot plasma.
-The models indicate a disk temperature of 0.755keV, an inner disk radius of 50.92 GM/c^2, a plasma temperature of 0.443 keV and a photon index of .321.
-This cool disk temperature confirms that the compact object is a black hole.
-The large disk radius implies the disk does not go all the way to the inner most stable circular orbit of the black hole, meaning the disk size could not be used to calculate the black hole's mass.



-This source is a high mass X-ray binary candidate in the galaxy M 108, located 46 million light years from Earth.
-The source was fit with a Compton scattering model.
-Comptonization occurs when photons emitted from the source encounter charged particles, most often relativistic electrons. If the photon hits the charged particle, it imparts some of its energy to the particle and it loses energy. If the charged particle transfer energy to the photon, the photon gains energy.
-The photons were initially emitted by a thermal component with temperature .608 keV.
-A Compton scattering model indicates a black hole as the compact object. Relativistic electrons are most often found in the accretion disks of black holes.

Time Variable Sources and Spectra

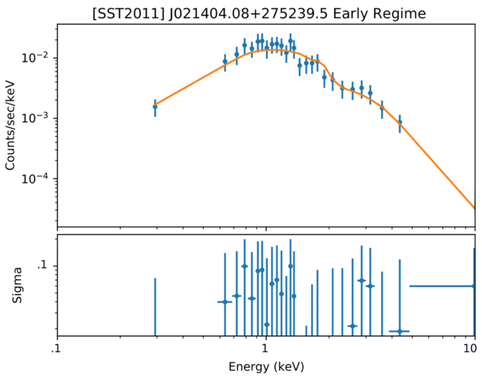
The following X-ray source from *Chandra* observation 9550 was seen to be variable and was split into three sections according to count rate to look for change in spectral type over time. As seen in the spectra, the source clearly changed over the course of the 16 hour observation



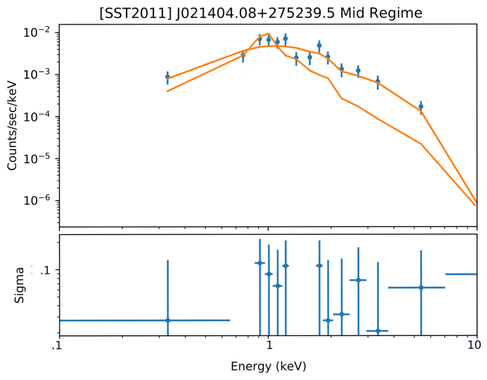
This source is an ultra luminous X-ray candidate in the galaxy NGC 855, located 155 million light years from Earth

The light curve shows clear variability, as verified by the glvary program which evaluates the changes over time in probability weighted bins.

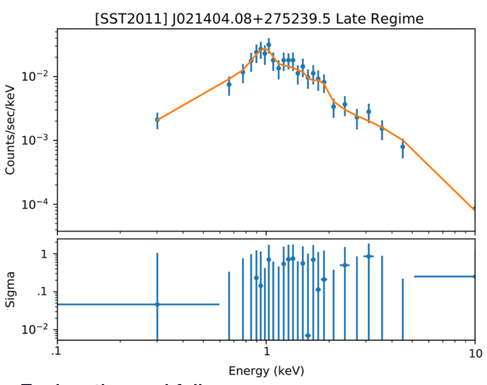
The light curve was used to identify 3 regions in time to analyze separately



-The early regime was fit with a black body disk model
-The fitted model indicates a disk temperature of 0.916 keV



-The middle regime was too low count to be fit by a physical model and draw meaningful conclusions about its properties
-It is shown here fit with both the early and late models, both of which provide a moderately good fit
-The mid regime is a low count transition state between the early and late



-The late regime was fit with a power law and hot plasma model
-The fitted model indicates a photon index of 1.645 and a plasma temperature of 0.968 keV

Explanation and follow-up:

-If the source is a low mass X-ray binary accreting through Roche lobe overflow, it is possible the Roche lobe emptied of material from the companion star and the accretion stopped or slowed down. This could explain the drop in flux and the change in spectral type from an accretion disk to a power law.
-If the source is a high mass X-ray binary, it is possible we witnessed an eclipse of the accretion disk by the companion star. As the star passes in front of the disk the source dims and the photons from the disk are obscured, but the coronal and plasma photons are not. This could account for the change in spectral type.
-More work is needed to fully understand this source. To put constraints on possible models, hardness ratio analysis can be used. Additionally, optical follow-up may allow for the classification of the companion star.

Models Used

-**Tbabs**[1]: Absorption from interstellar medium

-**Powlaw1d**[2]: 1 dimensional power law

-**Diskbb**[3]: Emission from a black body accretion disk

-**Diskpn**[4]: Emission from an accreting black hole disk

-**Mekal**[5]: Emission from hot, diffuse gas

-**Bbody**[6]: Emission following a black body spectrum

-**Bmc**[7]: Emission from comptonization of relativistic matter

-**Cflow**[8]: Emission from cooling flow

-**Compbb**[9]: Emission from black body comptonization

Sources

-From an existing database of over 12,000 X-ray sources in nearby galaxies, 136 sources were selected. This database contains all *Chandra X-ray Observatory* observations of nearby galaxies, selecting only the sources in those galaxies. This is done to increase the proportion of X-ray binaries in the sample and to exclude AGNs, which are not considered as part of this survey.

-Sources were selected based on a counts range. Only sources with normalized counts between 1000 and 1999 over the whole observation were considered. Such sources are sufficiently bright for detailed spectral and timing analysis but dim enough that they may have been passed over in prior study.

-Initial fitting efforts found a fit for 104 of the 136 sources.

-10 of the 32 unfit sources were thrown out for being possible AGNs

-5 of the 32 unfit sources were thrown out for telescope level observation problems making bad data.

-The remaining 17 unfit sources were fit with a pile up model and examined for over subtraction.

-All sources were examined for variability. 16 were found to be variable, with a variability index of at least 5.

-Of these 6 were ruled out of being variable because similar variability patterns were seen in their backgrounds and elsewhere on the CCD. These sources are most likely only variable because of telescope effects.

-The remaining 10 variable sources were split in time according to changes in their light curves.

-These split spectra were re-fit, looking for inter-observation spectral changes.

Acknowledgements

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Data analyzed and prepared with CIAO 4.12: Chandra's data analysis program (Fruscione et al. 2006, SPIE Proc. 6270, 62701V, D.R. Silvia & R.E. Doxsey, eds.) and Sherpa: a mission-independent data analysis application (P. E. Freeman, S. Doe, A. Siemiginowska SPIE Proceedings, Vol. 4477, p.76, 2001)
This research has made use of the SIMBAD database,operated at CDS, Strasbourg, France 2000,A&AS,143,9 , "The SIMBAD astronomical database", Wenger et al.

Citations

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