A Search For The Time Variability In The Population Of X-Ray Binary Systems In The Galaxy IC 342

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Abstract: X-ray binaries (XRBs) are comprised of a neutron star (NS) or stellar-mass black hole (BH) that is accreting material from a stellar companion. Studies of these sources yield insights into the properties of NSs and BHs as well as the dynamics of mass transfer and stellar evolution in binary star systems with sources at stages of advanced stellar evolution. Studies of X-ray binaries in the Galaxy are compromised by massive absorption extinction along Galactic lines of sight and by significant uncertainties in the distances to these sources. In contrast, studies of XRBs in nearby face-on galaxies with high current rates of star formation, locations at high Galactic latitudes and face-on orientations feature lower amounts of extinction. In addition, uncertainties in the distances to these XRBs are reduced to uncertainties in the distances to the host galaxies themselves. With this motivation, we are conducting a timing analysis of the XRB population in the nearby face-on spiral galaxy IC 342. Our analysis of archival X-ray observations that were made of this galaxy using the Chandra X-ray observatory have identified 123 discrete X-ray sources, the majority of which are XRB candidates. We are conducting a timing analysis on twelve of these sources detected at high confidence (at 1000 total counts or more) to identify variability both during an observation and between observations themselves. We have identified 9 sources that exhibit clear evidence for variability -- initial results will be presented and discussed.

Background and Motivation:

- Difficulty observing XRBs within the Milky Way due to where we are located within the galactic plane
- Extragalactic observations can be made to study XRBs
- Reduce uncertainty of distances to these objects and their host galaxies (IC 342)

Light Variability of XRB Candidates in IC 342:

- 9 Sources have shown definite variability in x-ray luminosity
- All 9 have over 1000 counts
- Found variability using glvary tool in CIAO

IC-342

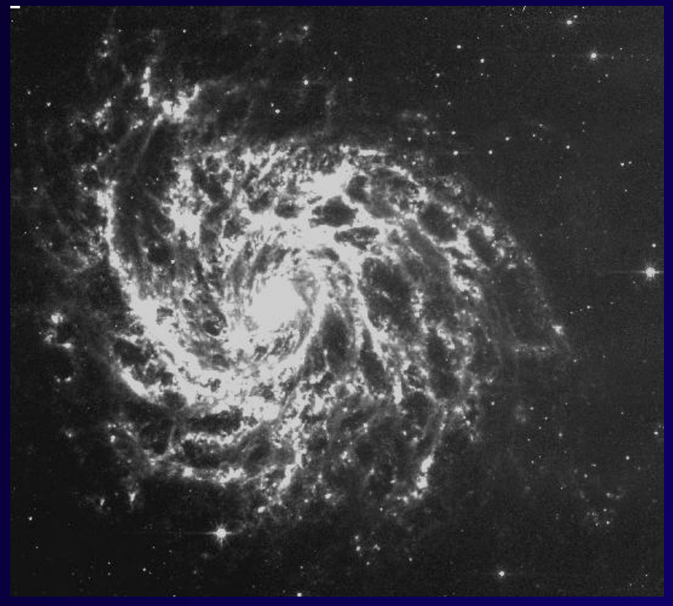

Figure 1: A Spitzer 8-Micron image of IC-342. IC 342 is a face-on spiral galaxy located 3.0 – 4.1 Mpc away from the Earth. Clearly defined spiral arms indicate extensive star formation activity. This extensive star formation activity implies the presence of a large resident population of discrete stellar x-ray sources, such as XRBs and/or Super Nova Remnants (SNRs).

Sources

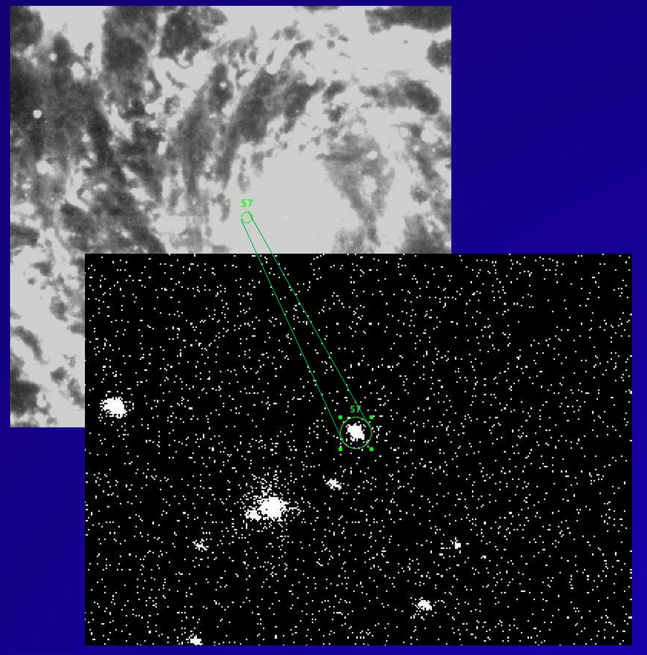

Figure 2.1: A zoomed in portion of the Spitzer 8-Micron image of IC 342 with one of the detected sources within a specified region labeled **57**.

Figure 2.2: This event image file made by the Chandra Observatory shows the source lying within the star cluster points towards the source being an XRB. This region is 5 arcseconds in diameter.

Source #	RA	Dec.	Variability Index
8	03:48:07.01	68:04:53.50	0
27	03:47:18.75	68:11:29.56	0
39	03:46:57.46	68:06:19.40	10
51	03:46:48.71	68:05:46.70	10
57	03:46:43.65	68:06:11.37	10
62	03:46:27.39	68:04:10.80	10
66	03:46:15.75	68:11:12.80	10
70	03:46:06.59	68:07:04.64	10
77	03:45:59.55	68:05:37.90	10
82	03:45:59.55	68:04:55.42	8
96	03:45:40.10	68:03:09.40	10
114	03:45:10.45	68:02:30.38	0

Figure 3: List of the 12 sources with over 1000 counts, along with position and their variability index. In this single observation, the glvary tool was used from CIAO which computes the probability of a certain source having a variable x-ray luminosity and scores it based of an index of 10, with 10 being definitely variable and 0 being definitely not variable. 8 of the 9 sources were rated 10 and the single source left was rated with an 8.

Analysis: From a total of 123 discrete X-ray sources only 12 sources had over 1000 counts and out of the 12, only 9 were shown to be variable. Almost all 9 sources lied within a star cluster as shown in Figure 2.2. Sources with 1000 or greater counts were chosen as a baseline for bright x-ray sources. Multiple observations of these same sources do exist and are currently being analyzed for any differences in variability.