X-ray Imaging Study of RCW49

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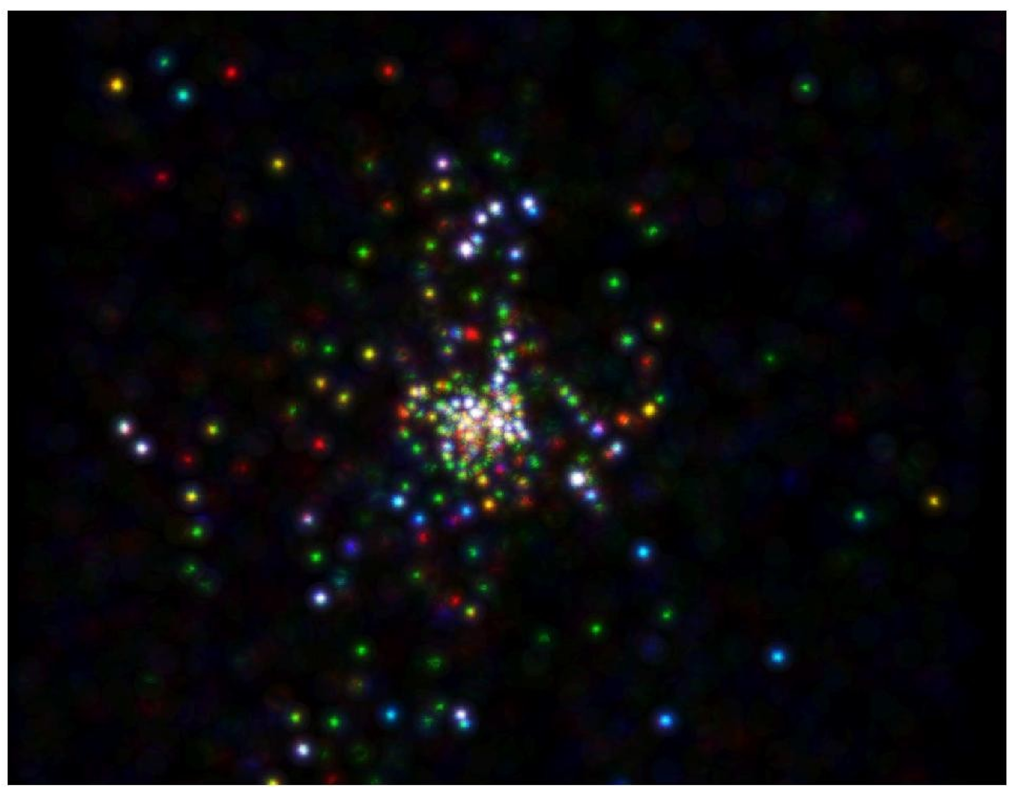
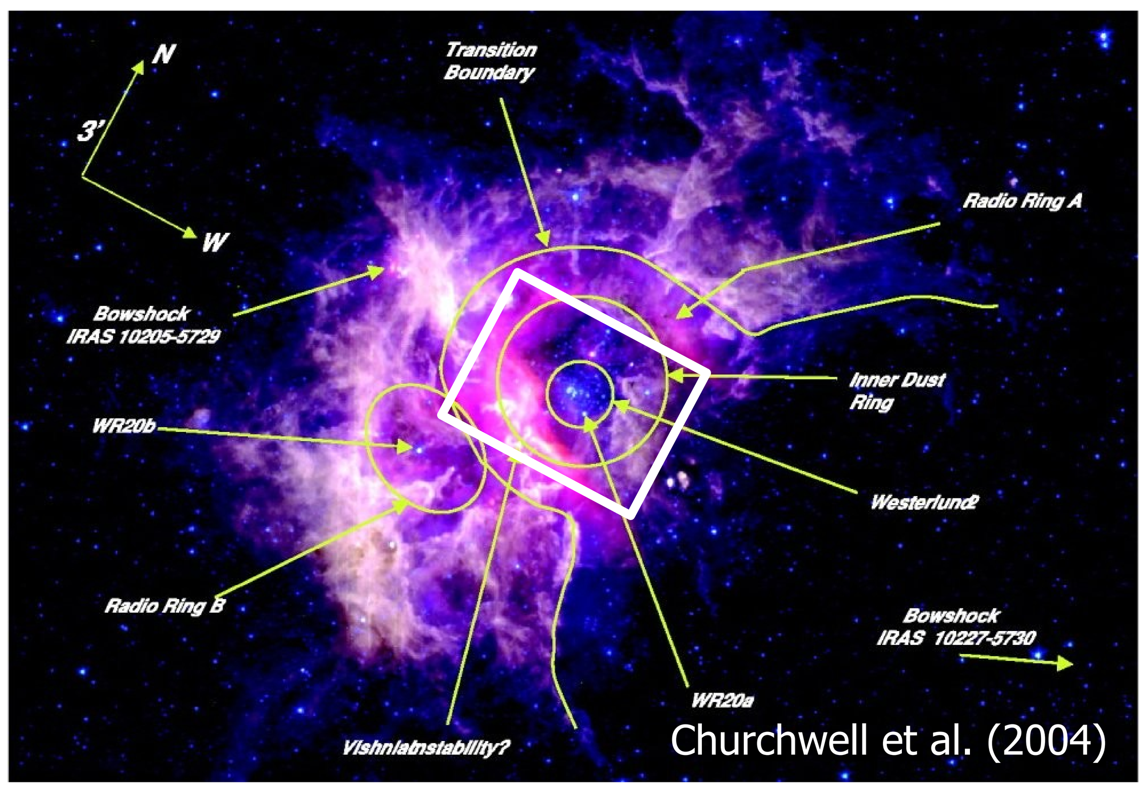
We observed RCW49, a typical Galactic massive star-forming cluster using the Chandra X-ray Observatory. IR data were combined.



Chandra ACIS imaging-spectroscopy (t_{exp}=40ks; 0.5-8 keV). 468 sources detected. Previous studies detected only 1 (Einstein)[2] and 7 (ROSAT)[3] sources. FoV=4.1'x5.3'. R (0.5-1.7), G (1.7-3.8), B (3.8-8.0 keV).

Concentric NIR image with IRSF SIRIUS (t_{exp}=30min, J, H, Ks bands). The same field with the panel on the left. R (2.2), G (1.6), B (1.2) μm.

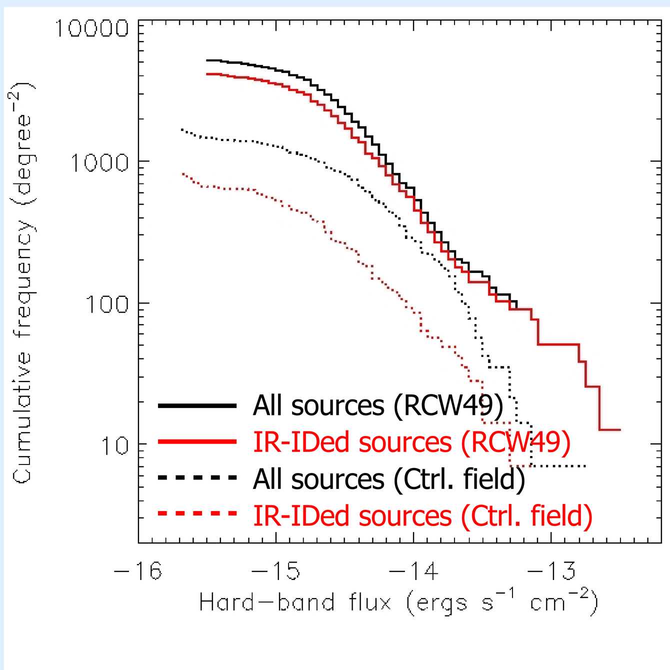


We retrieved MIR image obtained by Spitzer IRAC at 3.6, 4.5, 5.8, and 8.0 μm in the GLIMPSE database. The square region in the image represents the field of the two right-hand side panels.

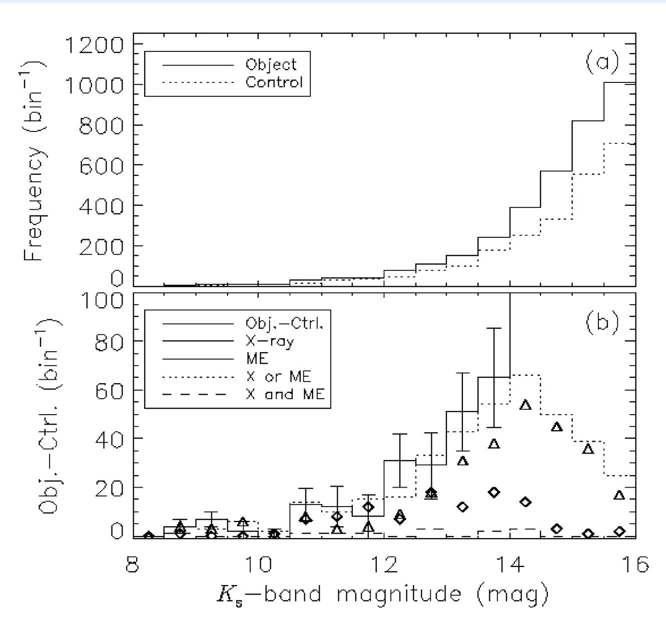
We learned the following from the X-ray + NIR and MIR imaging data sets on RCW49.

1. Cluster Membership

Unlike IR studies, X-ray samples in RCW49 suffers little contamination by fore- and background sources. The log(N)-log(S) curve of X-ray sources in RCW49 shows a ~10-fold overpopulation than the population in a control field in the Galactic Plane. About 86% of the IR-identified X-ray sources are considered to be RCW49 members.



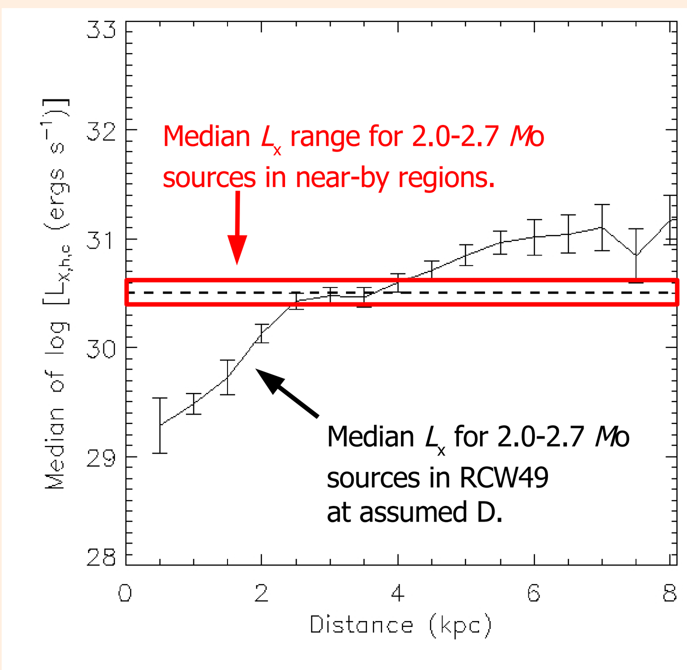
Most cluster members are late-type pre--main-sequence sources. X-ray census is sensitive both to weak-line and classical T Tauri stars by their enhanced X-ray activity. MIR census is sensitive to classical T Tauri stars and protostars by their excess emission from circum-stellar disks. and envelopes.



The K-band luminosity function (KLF) of RCW49 is reproduced partly by the KLF of X-ray sources or KLF of MIR excess sources, and almost completely by the union of the two at K<14mag. The intersection of the two is very small. X-ray and MIR excess censuses work *complementarily and completely* for the identification of cluster members.

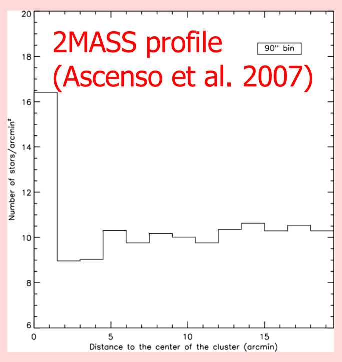
2. Distance

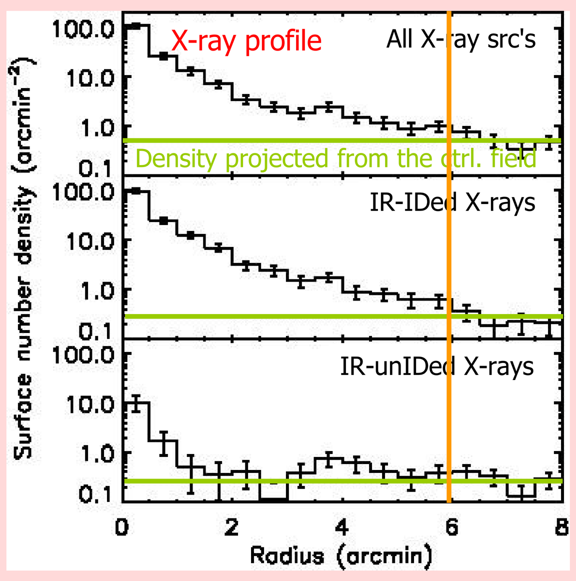
The distance to RCW49 is uncertain in the literature (D =2-8 kpc)[4]. We give a constraint of D =2.5-4.5 kpc using X-ray luminosity (L_x) v. stellar mass (M) relation[5]. L_x and M are derived from X-ray and NIR flux by assuming D. The figure shows the median L_x of X-ray sources with M =2.0-2.7 $M_\odot$ at each assumed D. Median L_x= $10^{30.5+/-0.1}$ erg/s established in near-by regions. D should be 2.5-4.5 kpc, so that L_x in RCW49 is in this range.



3. Cluster Size

The radial profile of the X-ray surface number density has a clear, monotonic decline to the background level at 6'-7' from the center. The cluster diameter (15-17 pc) is ~1.6 times larger than is appreciated in NIR imaging[6].

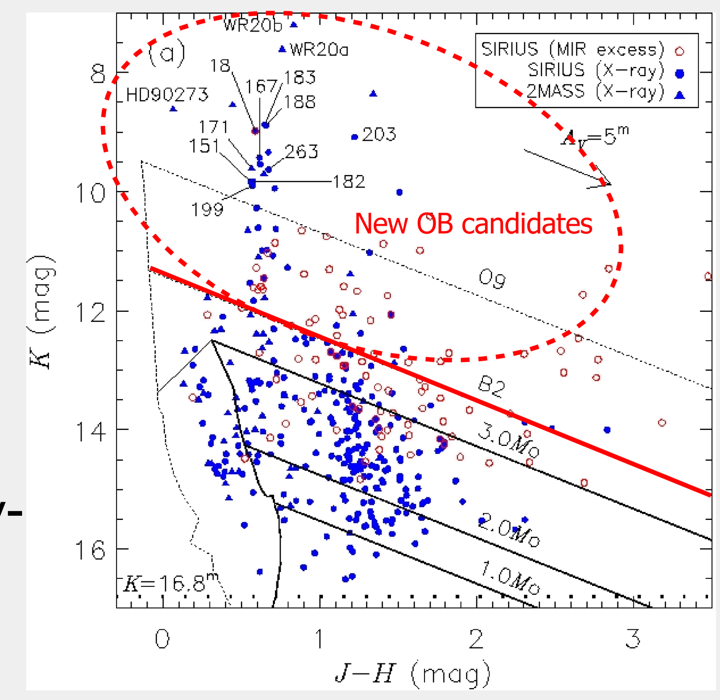




4. New OB Candidates

Because of the low level of contamination of X-ray samples, we can claim that all X-ray sources brighter than B2 are early-type stars in RCW49.

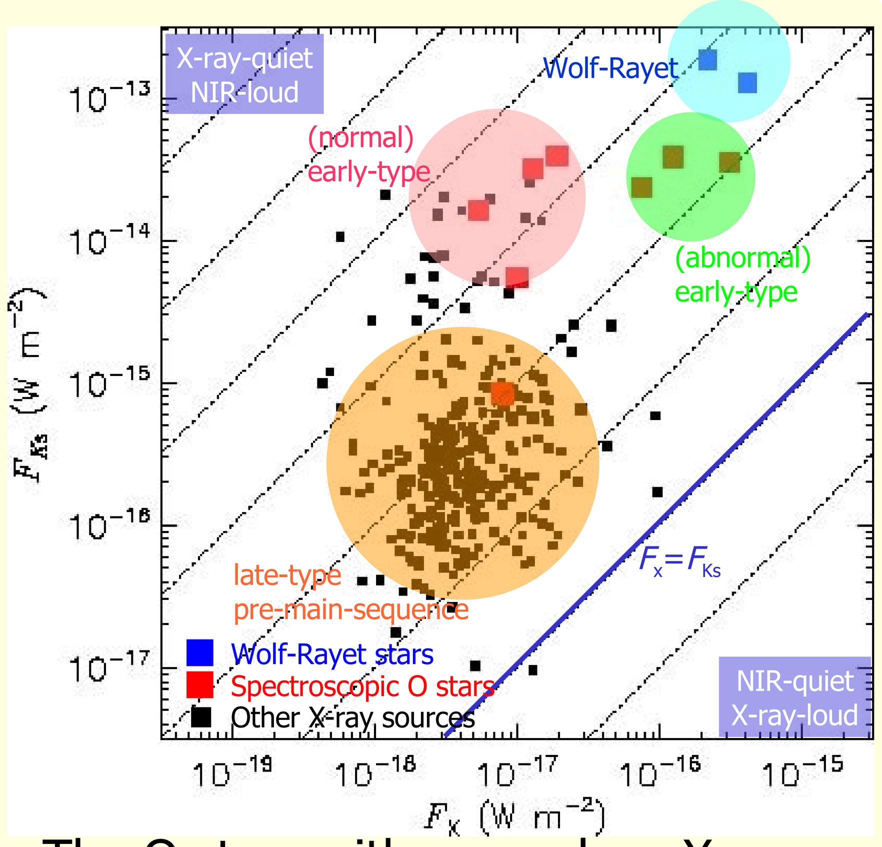
In the NIR color-magnitude diagram of X-ray sources, we identified 30 new early-type stars in addition to previously-known, spectroscopically-identified O stars[7].



About a half of the new OB stars are located outside of the central OB association.

5. O-O Binaries

Different class of X-ray sources occupy distinct regions in the F_{NIR} vs. F_X diagram. A few X-ray O stars deviate from the normal distribution (green area in the figure). Also, these stars have hard X-ray spectra unlike normal early-type stars.



The cause of the hard X-ray emission is unknown yet. One idea is the colliding wind shocks from two O-type stars in a binary. The O stars with anomalous X-ray hardness may be "X-ray spectroscopic binaries".

Please read ApJ, 665, 719 for detail. Thank you.

[1] Tsujimoto et al. 2007, ApJ, 665, 719
[2] Goldwurm et al. 1989, ApJ, 322, 349
[3] Belloni & Mereghetti 1994, A&A, 286, 935
[4] Churchwell et al. 2004, ApJS, 154, 322
[5] Getman et al. 2007, ApJ, 654, 316
[6] Ascenso et al. 2007, A&A, 466, 137