The Galactic Super Star Cluster Westerlund 1

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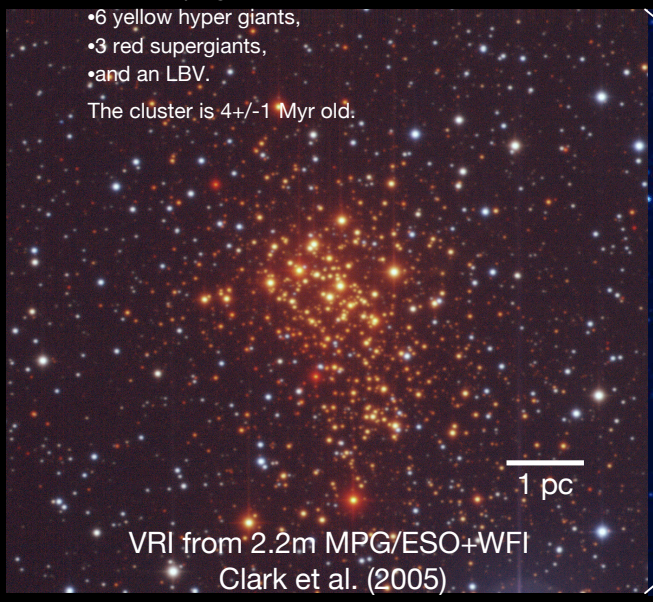
Westerlund 1 contains ~170,000 stars, including:

- Many main sequence O6 stars (35 $M_\odot$),
- 25 Wolf-Rayet stars,
- 80 OB supergiants,
- 6 yellow hyper giants,
- 3 red supergiants,
- and an LBV.

The cluster is 4+/-1 Myr old.

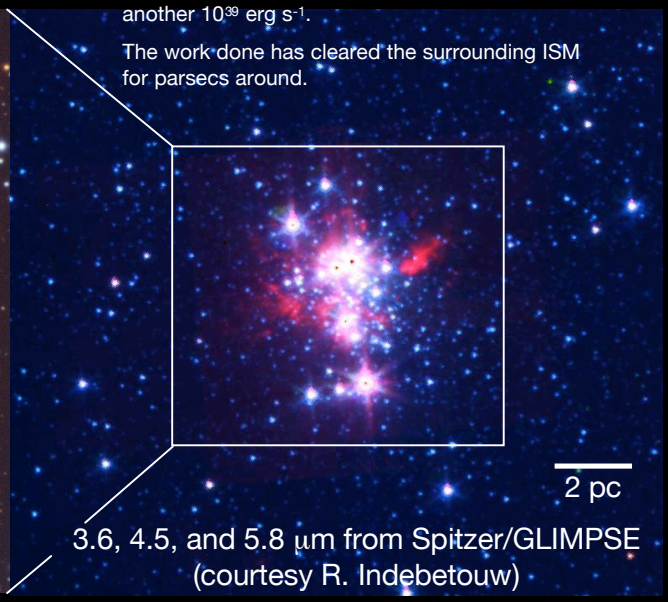


VRI from 2.2m MPG/ESO+WFI
Clark et al. (2005)

The winds from the 150 stars with $30<M_i<40\ M_\odot$ input 10^{39} erg s^{-1} into the ISM.

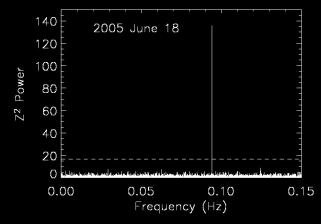
The 100 stars with $M_i>50\ M_\odot$ that have undergone supernovae in the last million years release another 10^{39} erg s^{-1}.

The work done has cleared the surrounding ISM for parsecs around.



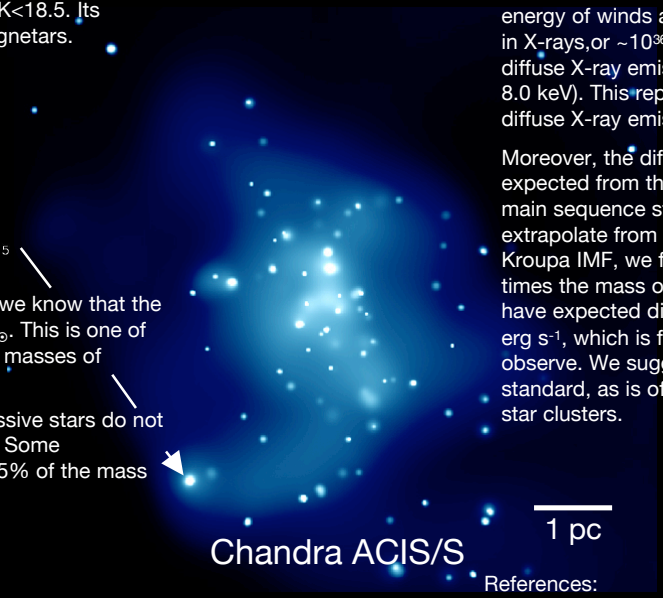
3.6, 4.5, and 5.8 μm from Spitzer/GLIMPSE
(courtesy R. Indebetouw)

The brightest X-ray source is a 10.6 s pulsar. It has no infrared counterpart with K<18.5. Its properties resemble those of magnetars.



From its presence in the cluster, we know that the pulsar's progenitor had $M_i>40\ M_\odot$. This is one of very few constraints on the initial masses of progenitors to neutron stars.

Our result demonstrates that massive stars do not always collapse into black holes. Some mechanism is required to eject 95% of the mass from these stars.



Chandra ACIS/S

Whereas we would expect ~10^{-3} of the kinetic energy of winds and supernovae to be dissipated in X-rays,or ~10^{36} erg s^{-1}, the luminosity of the diffuse X-ray emission is only 6×10^{34} erg s^{-1} (0.5-8.0 keV). This represents a factor of 10 deficit in diffuse X-ray emission.

Moreover, the diffuse flux is less than would be expected from the integrated emission from pre-main sequence stars with $M_i<3\ M_\odot$. If we extrapolate from the observed stars using a Kroupa IMF, we find that Westerlund 1 is ~90 times the mass of Orion. Therefore, we would have expected diffuse emission with $L_x = 3\times10^{35}$ erg s^{-1}, which is five times more flux than we observe. We suggest that the IMF is non-standard, as is often claimed for young, massive star clusters.

References:

Clark, J. S., Negueruela, I., Crowther, P. A., & Goodwin, S. P. 2005, A&A, 434, 949

Muno et al. 2005, astro-ph/0509408