The Intra-Cluster Medium of Globulars

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NAM 2007

Who?

Our collaboration

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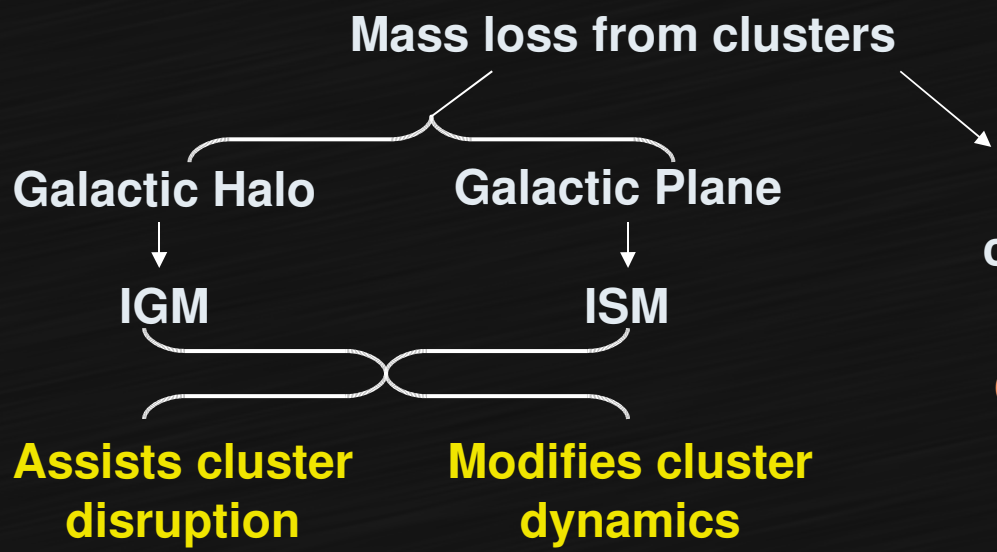
Why?

Why study mass loss?



➔ Implications for dSph galaxies.

- Mass loss mainly from giant branch stars.
- Total cluster output ~1 M / Myr.
- Clusters cross the galactic plane every ~100 Myr.

  ➔ ~100 M of intra-cluster medium (ICM) expected in the most massive clusters.

How?

How are we searching for the ICM?

- Several different methods exist to detect the ICM.
- These include:

Molecules

Rotational line emission

Molecular Gas

HI (21cm) emission

Dust

Continuum emission

Optical reddening

Atomic Gas

Diffuse H-alpha emission

Dispersion Measures

Diffuse X-ray emission

- Our team has used the Spitzer Space Telescope to search for continuum emission from intra-cluster dust.

How?

How are we searching for the ICM?

- The significant "detections" of ICM are shown below:

Team	Cluster	Instrument	Type	Mass found ($M_\odot$)	Implied Total Mass ($M_\odot$)*
Boyer et al.	**M15**	**Spitzer**	**Dust**	**9×10^{-4}**	**~33**
Evans et al.	**M15**	**ISOPHOT**	**Dust**	**5×10^{-4}**	**~18**
van Loon et al.	**M15**	**Arecibo**	**H I**	**~ 0.3**	**~ 0.3**
Freire et al.	**47 Tuc**	**PSR DMs**	**H^+**	**~ 0.2**	**> 0.2**
Faulkner et al.	**NGC 2808**	**Parkes**	**H I**	**≤ 200**	**≤ 200**

* Using dust/gas = 200 * (Z / 0.019), totals for H^+/H I detections depend on ionisation of hydrogen.
Other detections yield only upper limits, not all clusters surveyed.

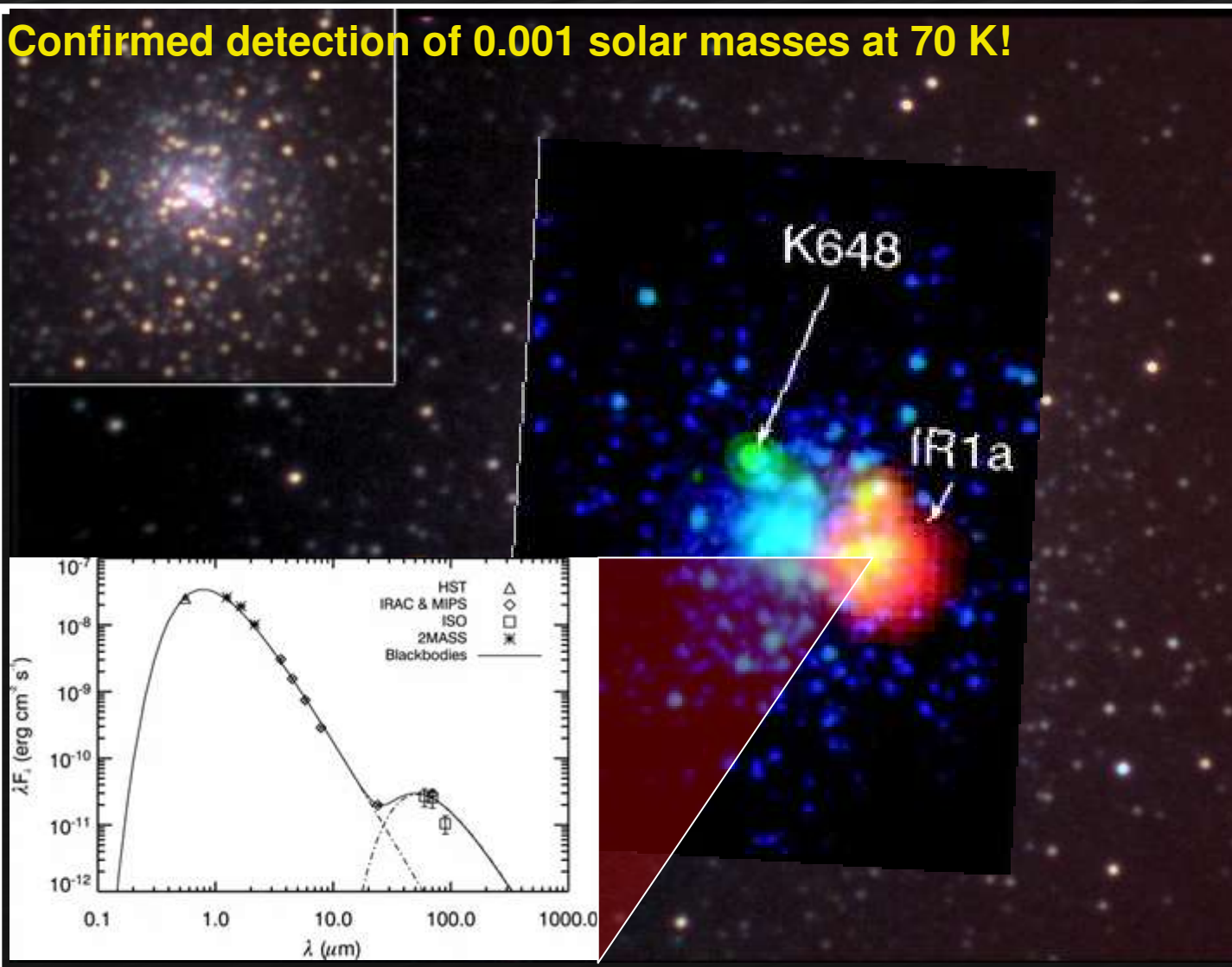
- So many clusters… so little ICM.
- Where has all the ICM gone?

➔ Some clearing mechanism is continually removing it.

Where?

M15

Confirmed detection of 0.001 solar masses at 70 K!



Where?

Omega Centauri

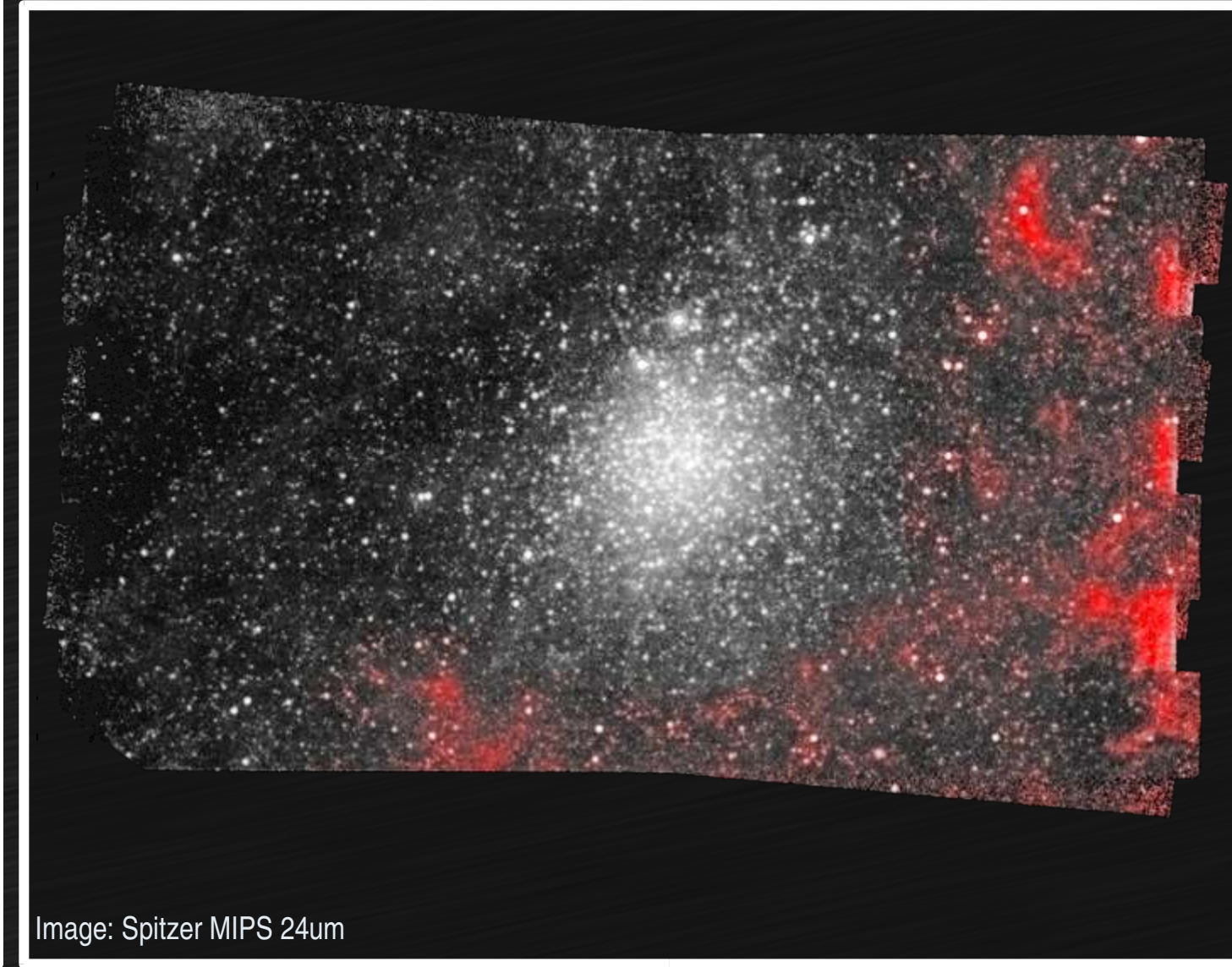
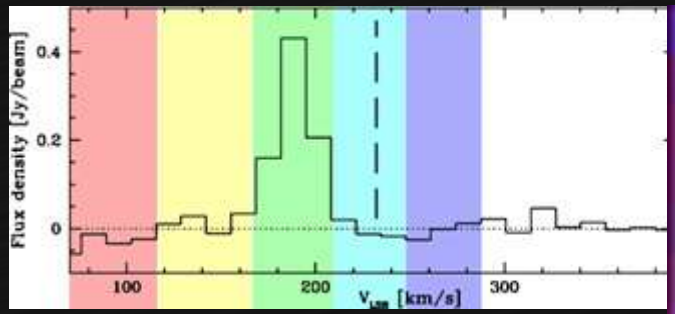
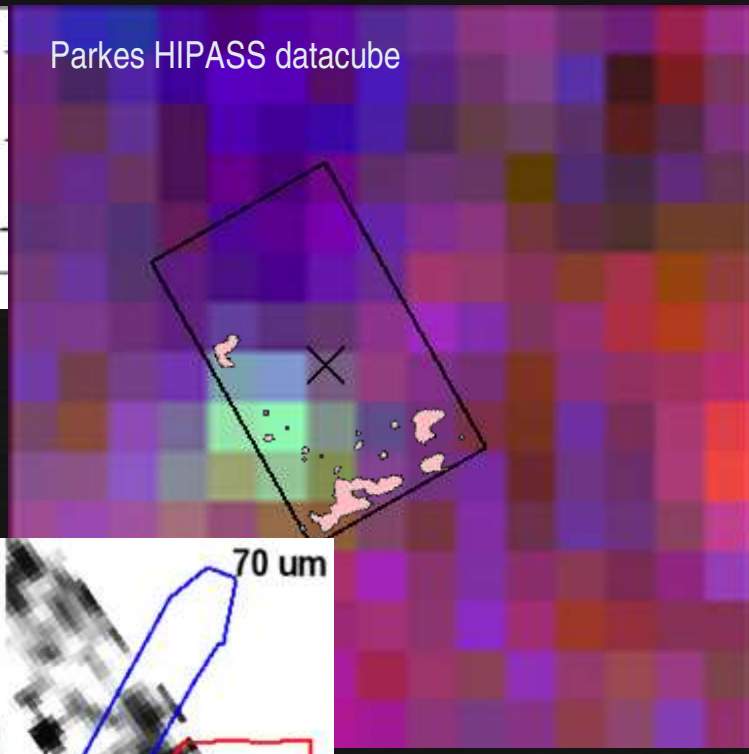


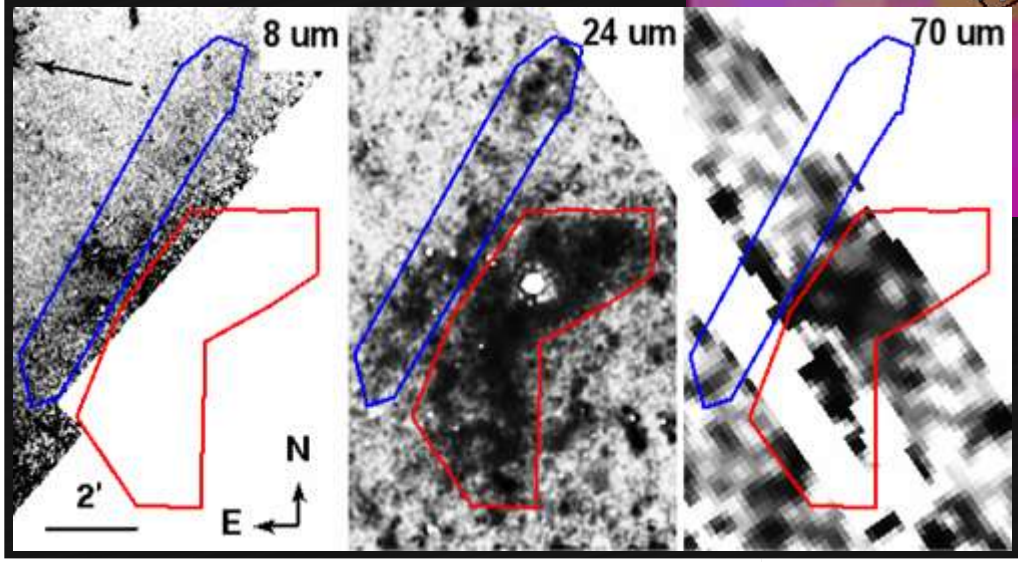
Image: Spitzer MIPS 24um

What?

What's going on?







What?

What's going on?

What's happening in ω Centauri?

- Extended 24 μm emission near ω Centauri.
- Emission appears curved, centred on the cluster.
- Close to an isolated, compact H I source near cluster's v_{rad}.

➔ It may be ICM being expelled from the cluster.

- We have secured ATCA time to observe the cloud in H I.
- This should allow us to spatially resolve the H I source.

What?

What's going on?

Why don't we see it ICM in all globular clusters?

- We don't know!

- M15 is extremely metal poor and dense.
- ω Cen is the most massive globular cluster.

➔ Metallicity and/or cluster escape velocity may play a dominant role in mass retention.

- Alternatively, mass loss within clusters may be episodic.

➔ We only see ICM in clusters during times of high mass loss.

- This could be associated with the disruption of a planetary nebula, or represent a superwind phase of an AGB star.

What?
Conclusions

- Following a detection of intra-cluster dust in M15, we may have found extended dust emission from ω Centauri.
- It may be associated with a hydrogen cloud at roughly the right radial velocity.
- If this is true, it may mean that mass loss from clusters does not occur at a constant rate, but is highly episodic.
- Gas appears to be removed continuously, probably by ram pressure from the halo gas

➔ Removal of ICM is important for the disruption of clusters.