

Finding Hidden Supernovae with Laser Guide Star Adaptive Optics on Gemini

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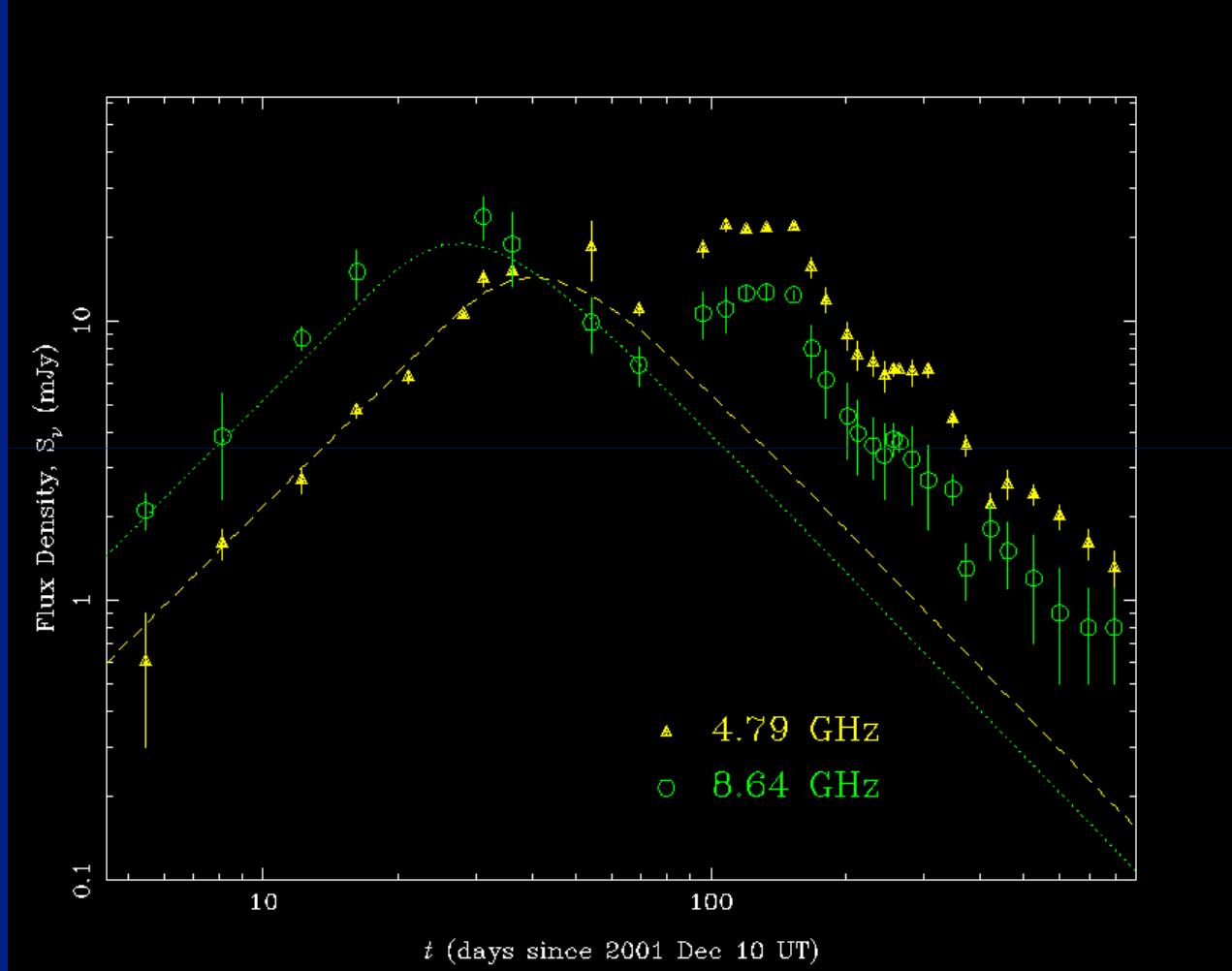


Where are all the missing SNe?

- Optical searches (amateur + robotic) found 584 SNe in 2007, but only 279 in 2008.
- Core-collapse supernova (CCSN) rates directly trace SFR(z) via IMF, key input to galactic chemical evolution models.
- Radio monitoring of CCSNe probes circumstellar medium, recreates mass-loss history of progenitor.



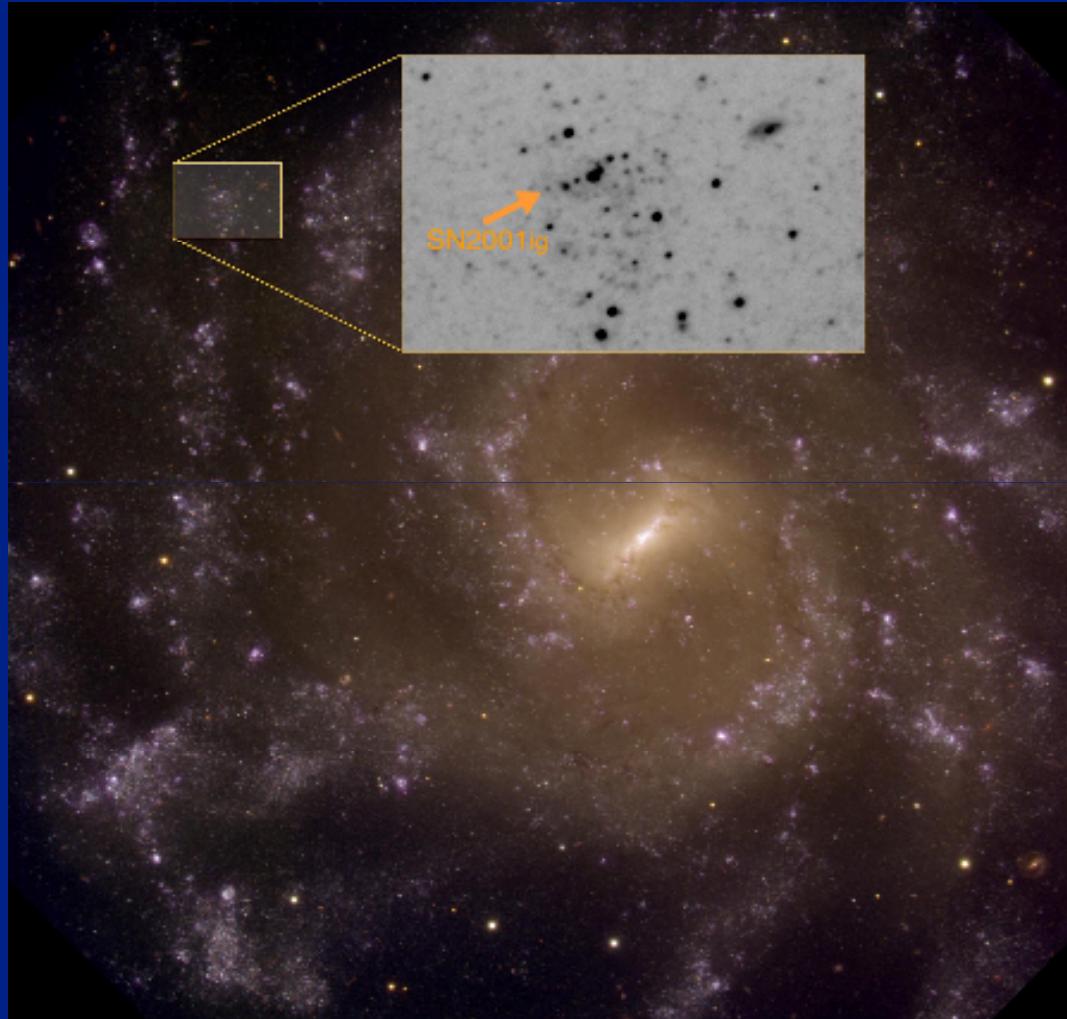
The Type IIb SN 2001ig



Ryder et al. 2004, MNRAS, 349, 1093



The Type IIb SN 2001ig



Ryder et al. 2006, MNRAS, 369, L32

Supernova Safari

- LIRGs ($L_{\text{FIR}} > 10^{11} L_{\odot}$) and ULIRGs ($L_{\text{FIR}} > 10^{12} L_{\odot}$) ideal “hunting grounds” for SNe.
 - *BUT* LIRGs have:
 - High dust content (use NIR)
 - Complex nuclear structure (high spatial resolution)
 - Extended nuclear + disk structure (few natural guide stars)
- \Rightarrow Laser Guide Star Adaptive Optics!
- Mattila, Ryder, et al. (2007) found SN 2004ip in IRAS 18293-3413 with NACO + NGS on VLT
First adaptive optics-assisted SN discovery

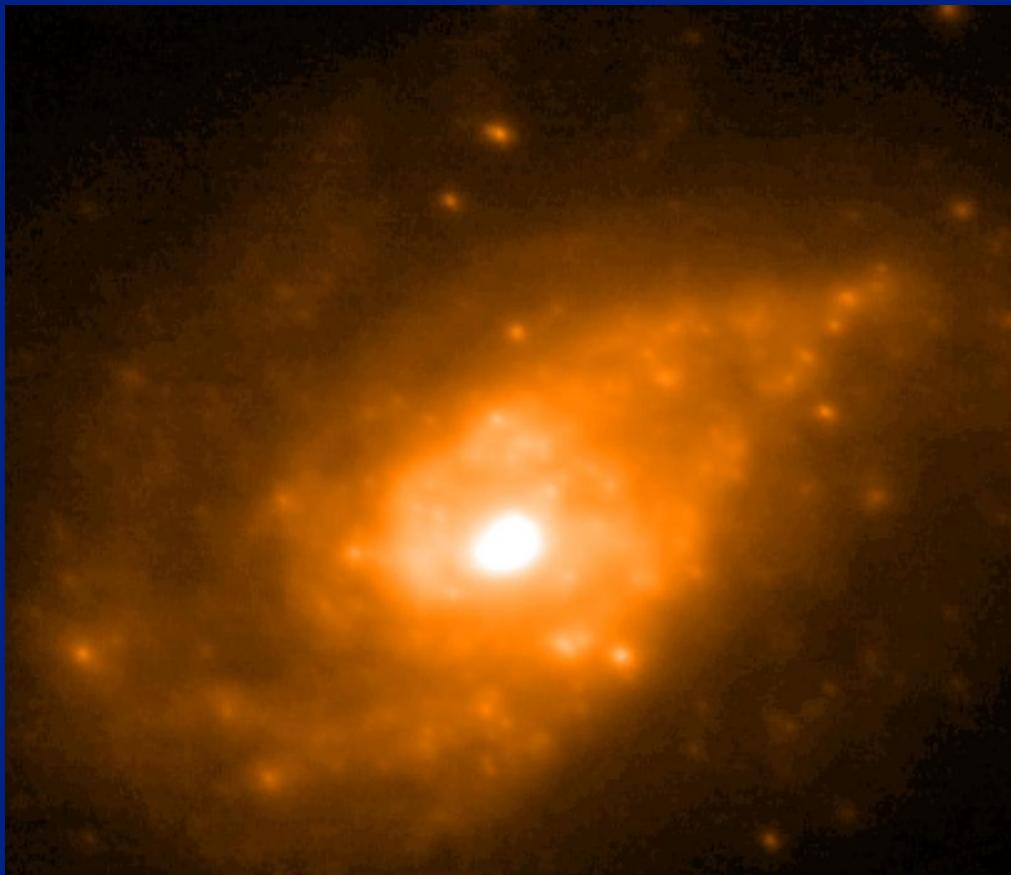


The Hunt

- 2008A – 2010A: Monitor 8 LIRGs with NIRI/ALTAIR + LGS on Gemini North at 2 – 6 month intervals.
- LIRGs from IRAS RBGS with $d < 100$ Mpc, no AGN contribution, $R < 18.5$ TTGS within 25".
- Expect 8 CCSNe/yr in sample, simulations indicate 6 recovered over 5 semesters.
- 9×30 sec integrations in K on target and sky, $< \frac{1}{2}$ hr per visit, FWHM $\sim 0.1''$.
- Optimal Image Subtraction (Alard 2000) uses space-varying convolution kernel to match images from different epochs before subtraction.



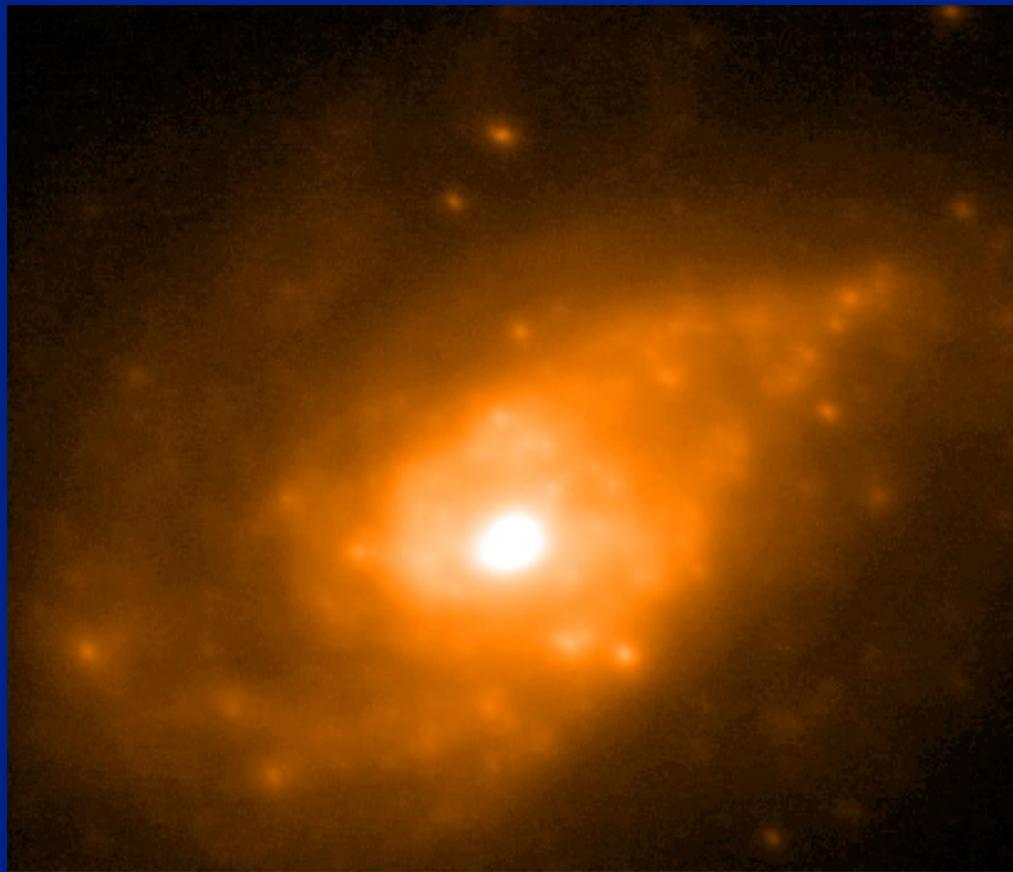
IRAS 18293-3413



2004 May 4.3
VLT/NACO



IRAS 18293-3413

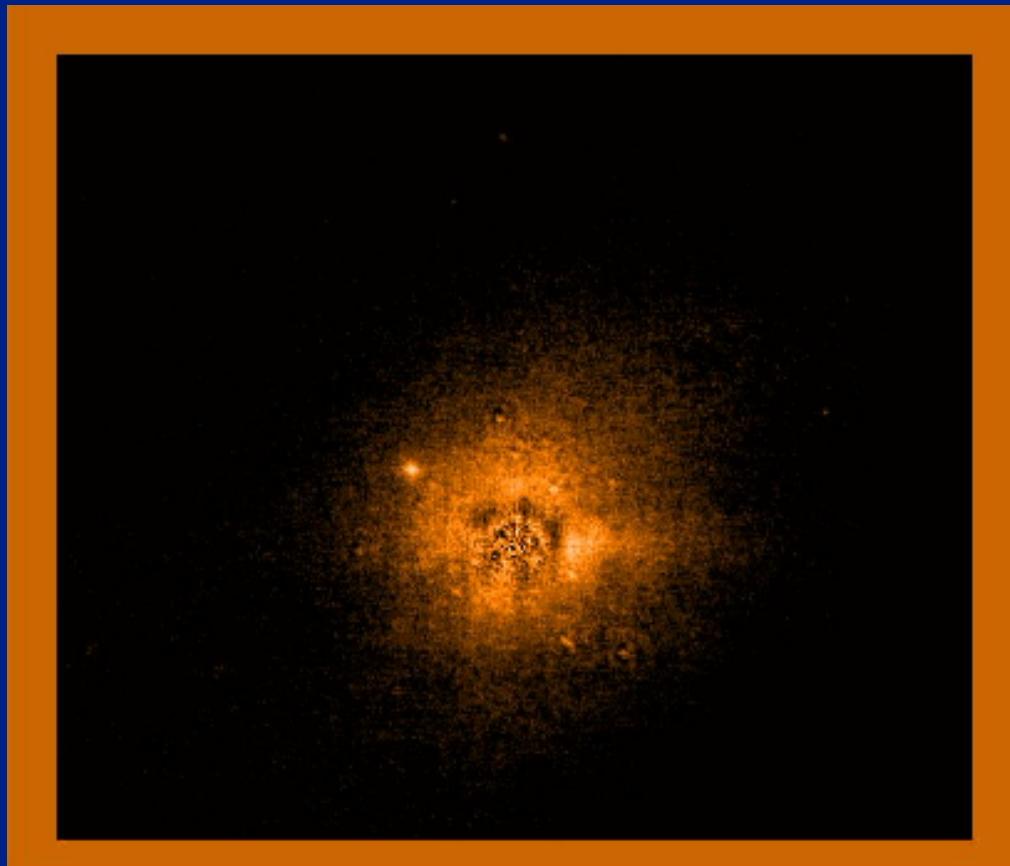


2004 Sep 15.0
VLT/NACO



SN 2004ip in IRAS 18293-3413

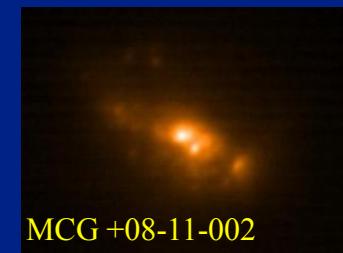
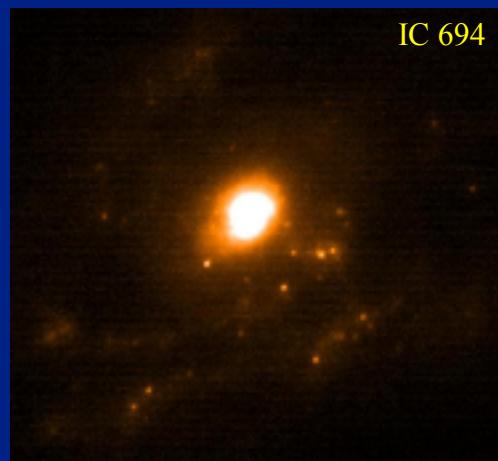
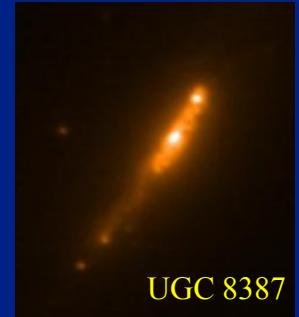
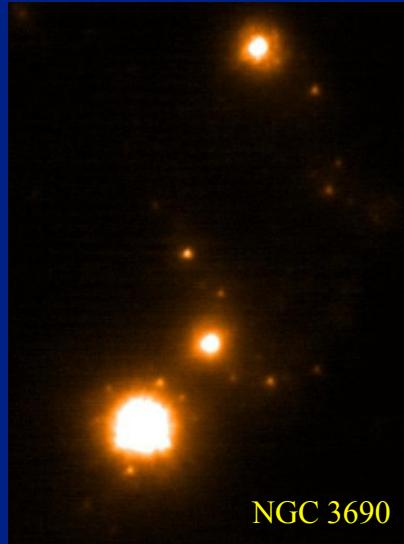
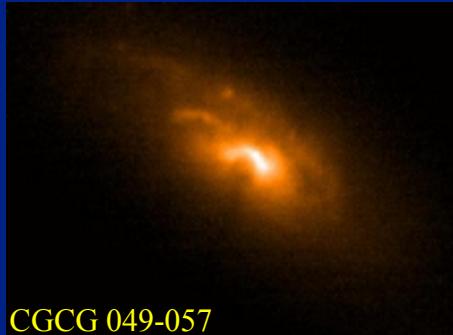
Mattila et al. 2007, ApJL, 659, L9
Perez-Torres et al. 2007, ApJL, 671, L21

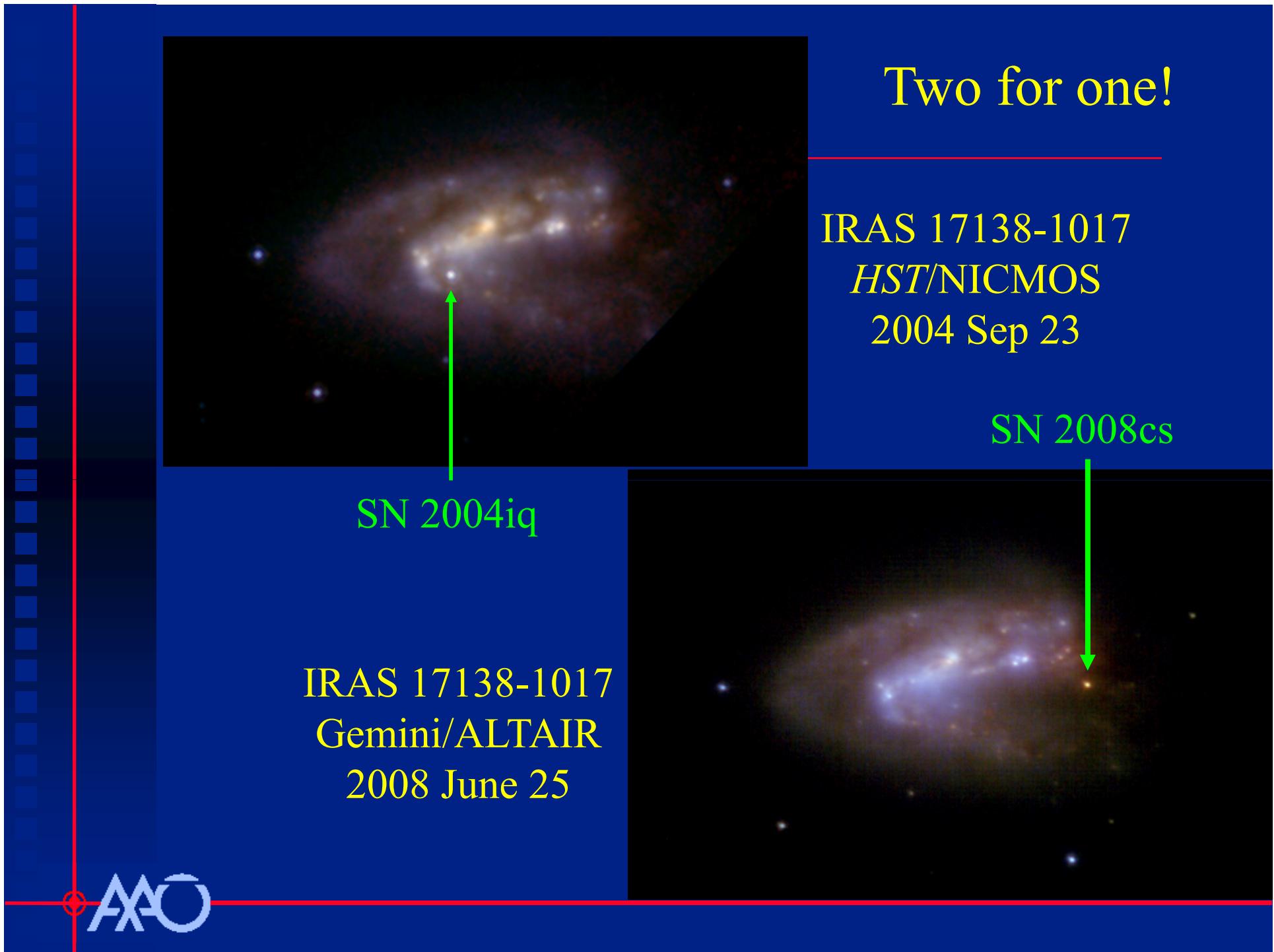


Sep – May



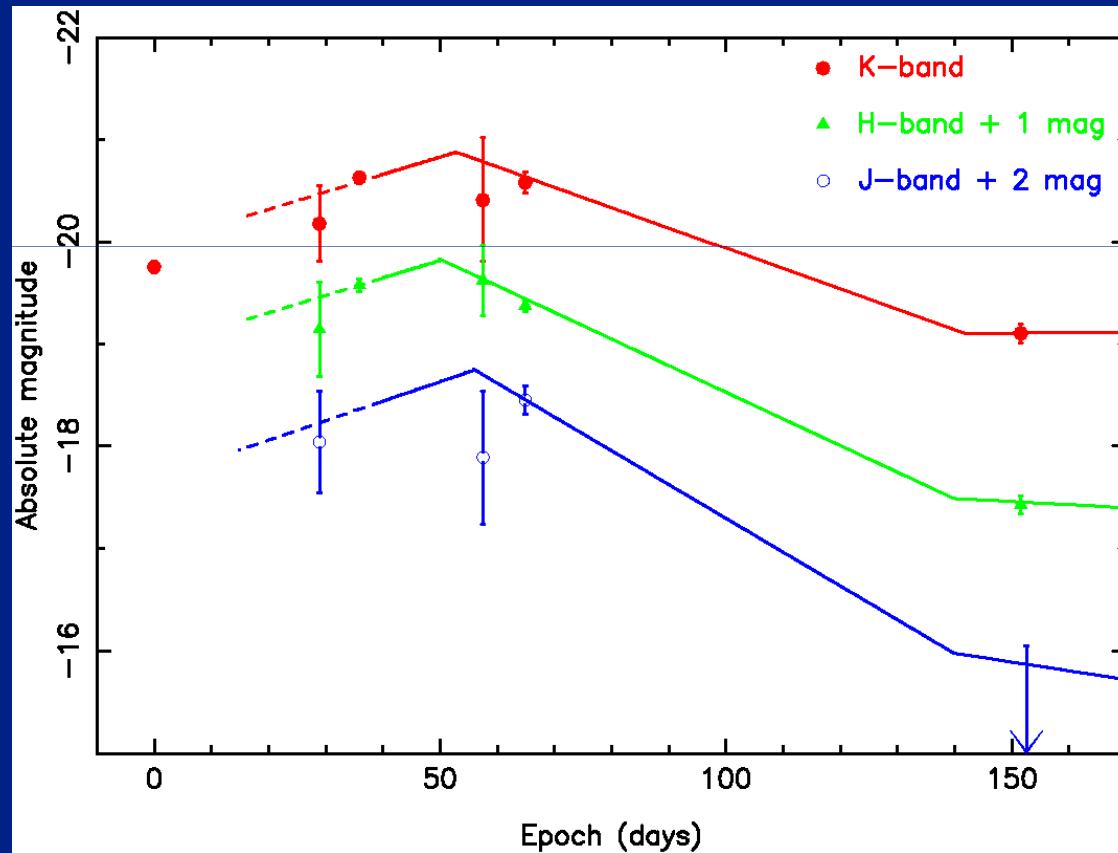
Meet the LIRGs





Out of sight

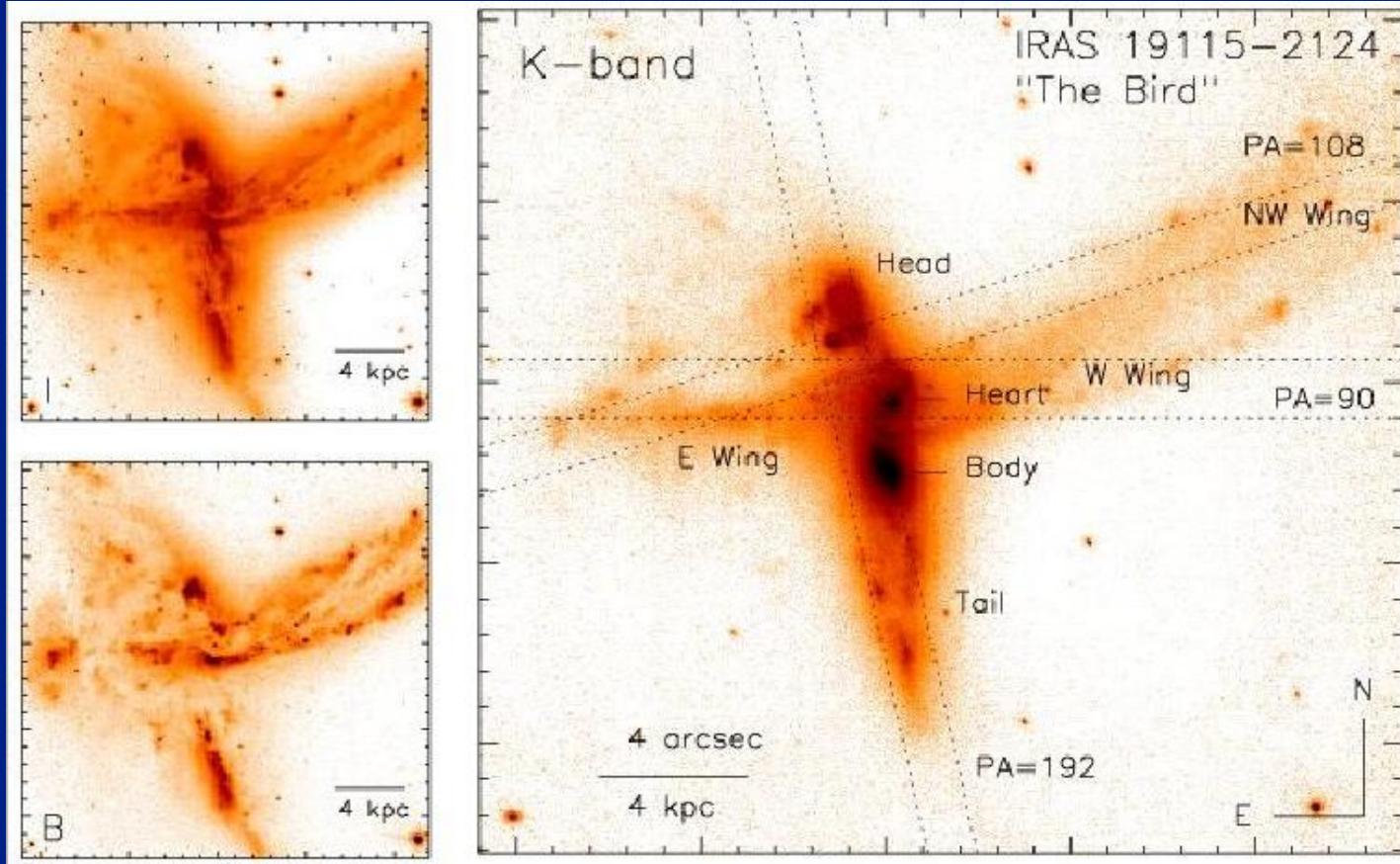
- Template fits $\Rightarrow A_K \sim 1.8$, or $A_V \sim 18$ mag
- < 1 in 10^6 optical photons escape!



Kankare et al. 2008,
ApJL, 689, L97



“Value-added” science I



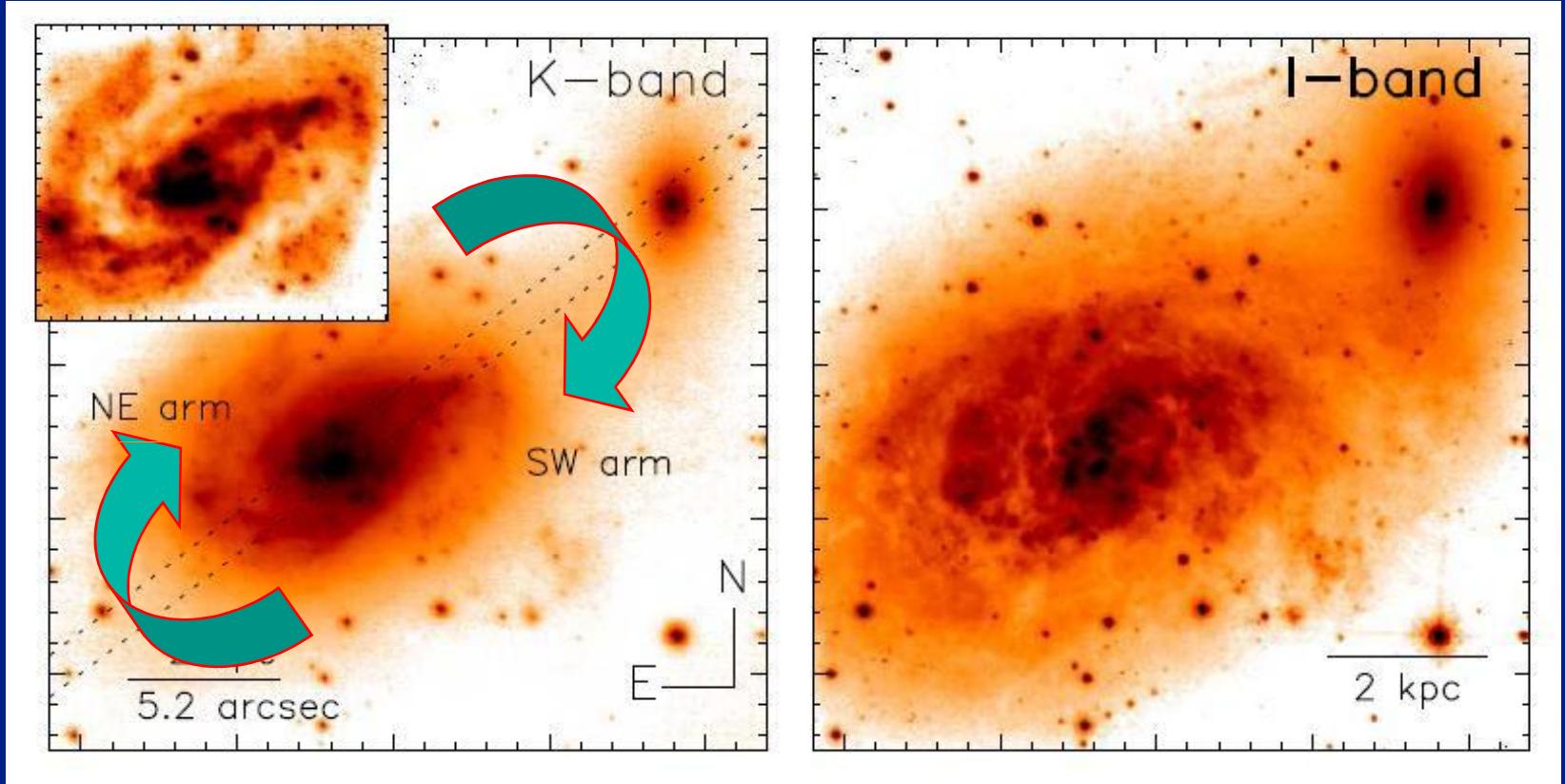
IRAS 19115-2124: “The Bird”

VLT/NACO

Väisänen et al. 2008, MNRAS, 384, 886



“Value-added” science III



IRAS 18293-3413: Leading Spiral Arms?
VLT/NACO

Väisänen et al. 2008, ApJ, 689, L37



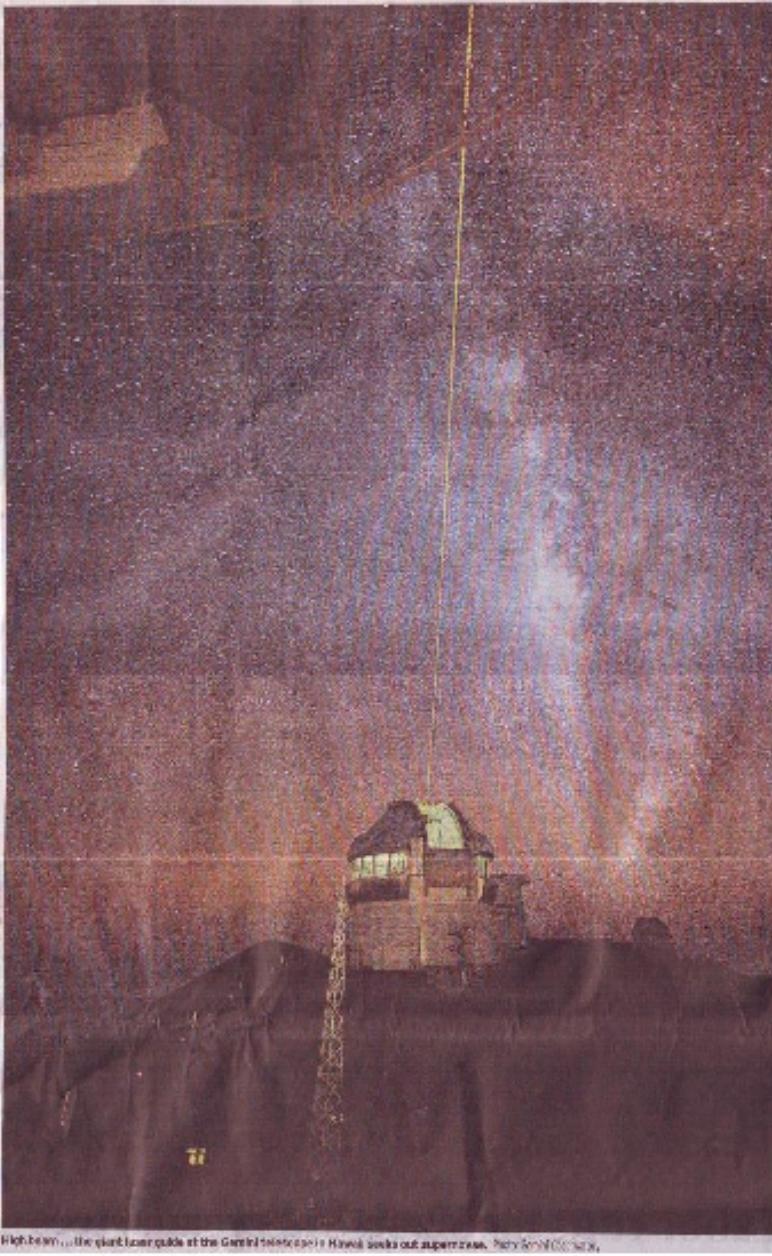


One possible explanation is that science's understanding of stars is wrong. Another is that dying stars, "like cockroaches dying unseen under the couch", are easily missed.

Mon 5 February 2009

The Sydney Morning Herald

Laser explodes mystery of how a star is born



Richard Macey

20090205 expl-laser-1
Astronomers of the Gemini Observatory in Mauna Kea, Hawaii, have used a laser to illuminate a star-forming cloud in the Andromeda galaxy.

"We can compare it 10,000 times more precisely than the next generation in 2020," said the astronomer from the Anglo-Australian Observatory, Peter Coughlin, who leading an international team using a visible wavelength to explore a star-forming region in the Andromeda galaxy.

"It would be quite easy now for us to look right down the road."

About \$5 million has been spent on the building, running and maintaining the equipment.

Mr Macey, president of the International Astronomical Union, said the team had developed a system to identify galaxies. "We are using a laser to point to a specific star," he said. "That's really important, because stars are small."

One possible explanation is that stars' internal light can be obscured by dust or other objects. "The star-forming regions are very hard to reach," he said.

To demonstrate the technique, the team has performed a test at the Gemini Observatory in Hawaii's Mauna Kea, at an altitude of 4232m.

Astronomers usually have to use cameras to produce successive images by canceling the blurring effect of Earth's atmosphere with electronic sensors.

A US team has claimed 90% accuracy in the sky surveying to plot nearby "unfriendly stars".

Their spokesman, Michael Shao, said: "We can also expect to get 100% of the light within the field by averaging over three observations.

International teams are also

working on the same problem.

Competitors include the European Southern Observatory's Very Large Telescope in Chile.

The German team, led by Dr Stephan Hartung from the University of Cologne, has developed a system to measure the temperature of the star.

When a star is born, it has a high temperature, although its colour is red. As it grows older, its temperature drops and its colour changes to blue.

When a star reaches the end of its life, it has a low temperature, although its colour is white. This is called a white dwarf.

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Summing Up

- Expect ~6 new SNe after 2 years – found one so far!
- If no more are found, then
 - Template lights curves and MC simulations of blending too optimistic?
 - LIRGs even dustier than assumed?
 - FIR luminosity over-predicts SFR?
- MCAO + GSAOI will greatly expand SN search
- Gemini's (and Subaru's) current + future instrumentation are great stellar forensic tools

