

LOOKING INTO THE HEART OF A YOUNG OUTBURSTING STAR: FIRST AU-SCALE OBSERVATIONS OF V1647 ORI WITH VLTI/MIDI

ÁGNES KÓSPÁL

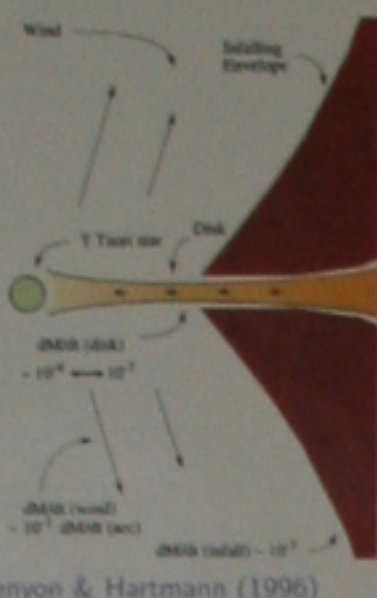
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FU ORIONIS-TYPE STARS (FUORS)

- Low-mass, pre-main sequence stars exhibiting optical outbursts of ≈ 5 mag;
- Outbursts are due to enhanced accretion from the circumstellar disc to the star, caused by thermal instability;
- The enhanced accretion can be
 - spontaneous
 - triggered by the passing of a close companion



THE OUTBURST OF V1647 ORI

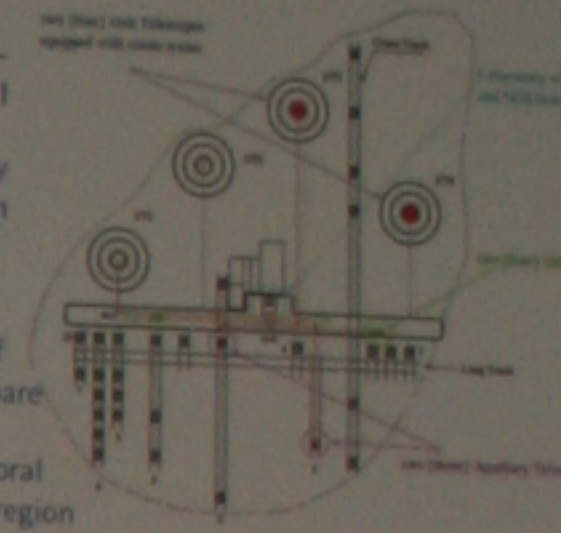
- In January, 2004 a new reflection nebula (McNeil's Nebula) appeared in the LDN1640 dark cloud of the Orion B molecular cloud complex;
- V1647 Ori, whose outburst caused the appearance of McNeil's Nebula, is a low-mass, pre-main sequence object;
- Optical brightening: 5 mag in I_c -band;
- Pre-outburst luminosity: $5.4 L_{\odot}$
Outburst luminosity: $44 L_{\odot}$;
- Spectrum: flat in νF_{ν} between 2 and $60 \mu\text{m}$;
- FU Orionis-type candidate.



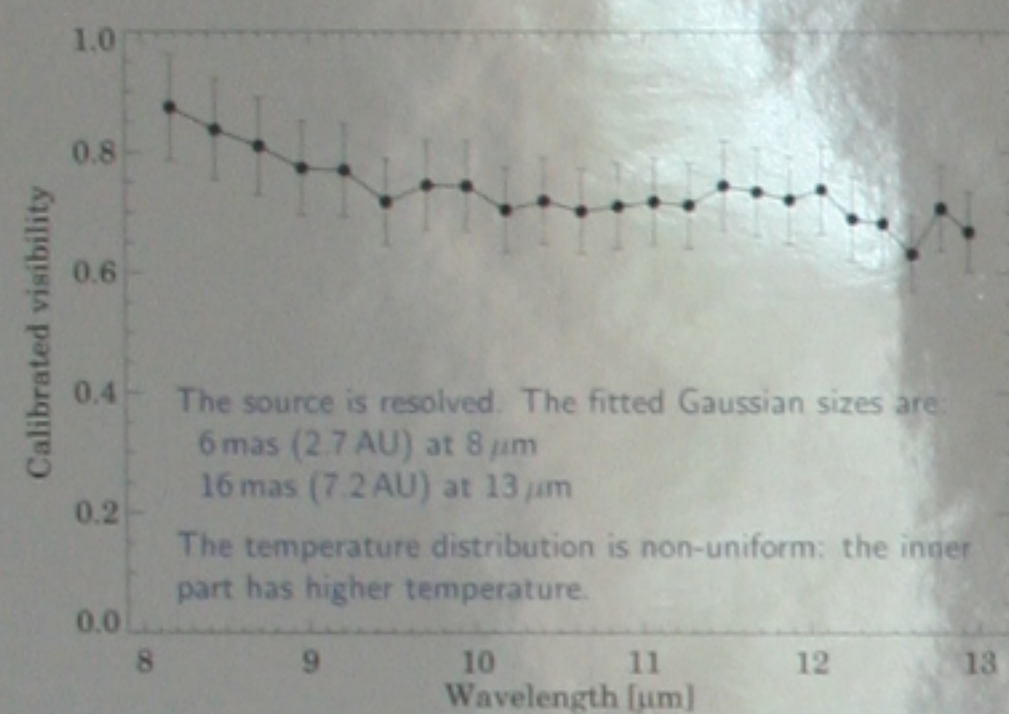
Reipurth & Aspin (2004)

MIDI OBSERVATIONS OF V1647 ORI

- MIDI: Mid-Infrared Interferometric Instrument on the VLTI
- DDT (Director's Discretionary Time) proposal to ESO in November 2004
- Aims:
 - Investigate the structure of the hot inner source, compare to models
 - Start monitoring the temporal evolution of the hot inner region
 - Look for possible close companions
- Successful observation: March 2, 2005
- Data reduced with MIA (see e.g. Leinert et al. 2004)



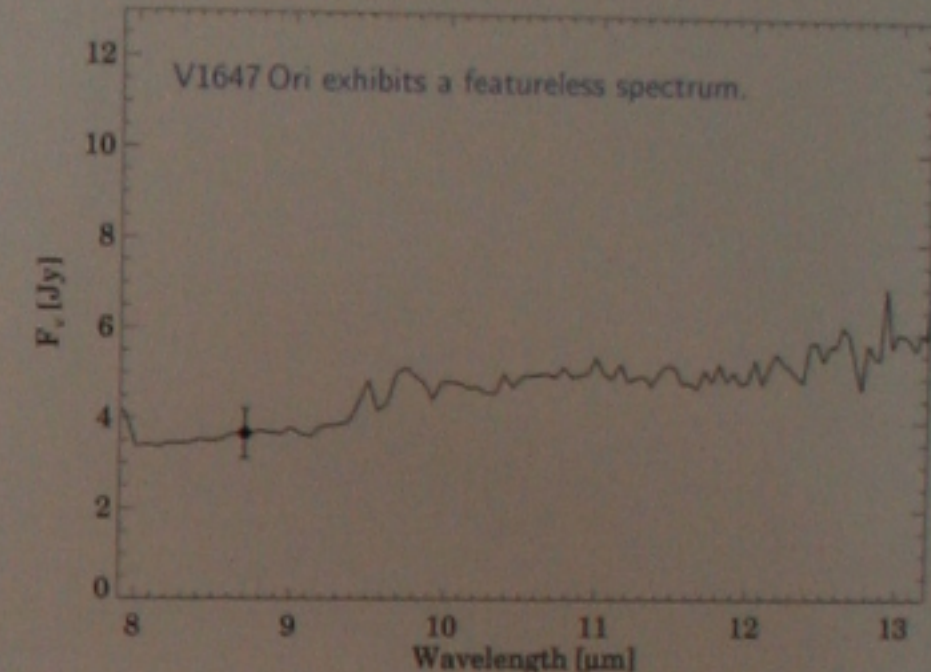
RESULTS: SPECTRALLY RESOLVED VISIBILITIES



RESULTS: SEARCH FOR COMPANION

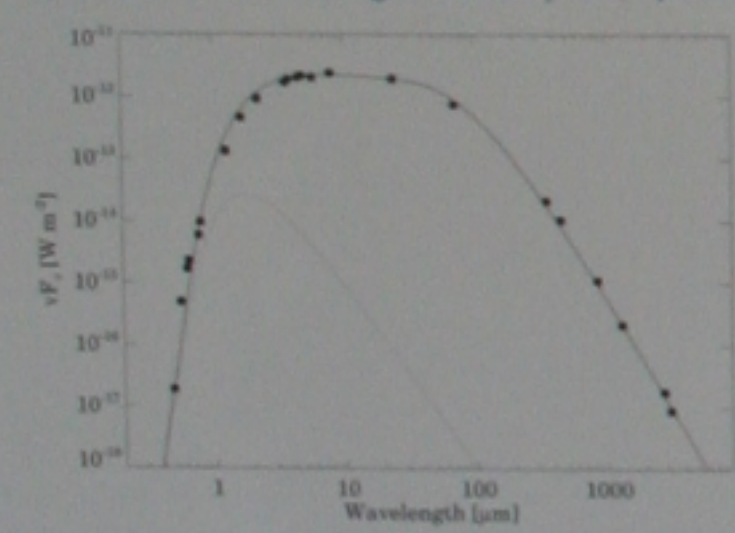
- A signature of a companion is the sinusoidal modulation of the spectrally resolved visibilities.
- We determined an upper limit for the brightness of a possible companion.
- No companion is detected at the measured position angle whose separation is less than 100 AU and brightness ratio to V1647 Ori is greater than 10%.

RESULTS: N-BAND SPECTRUM



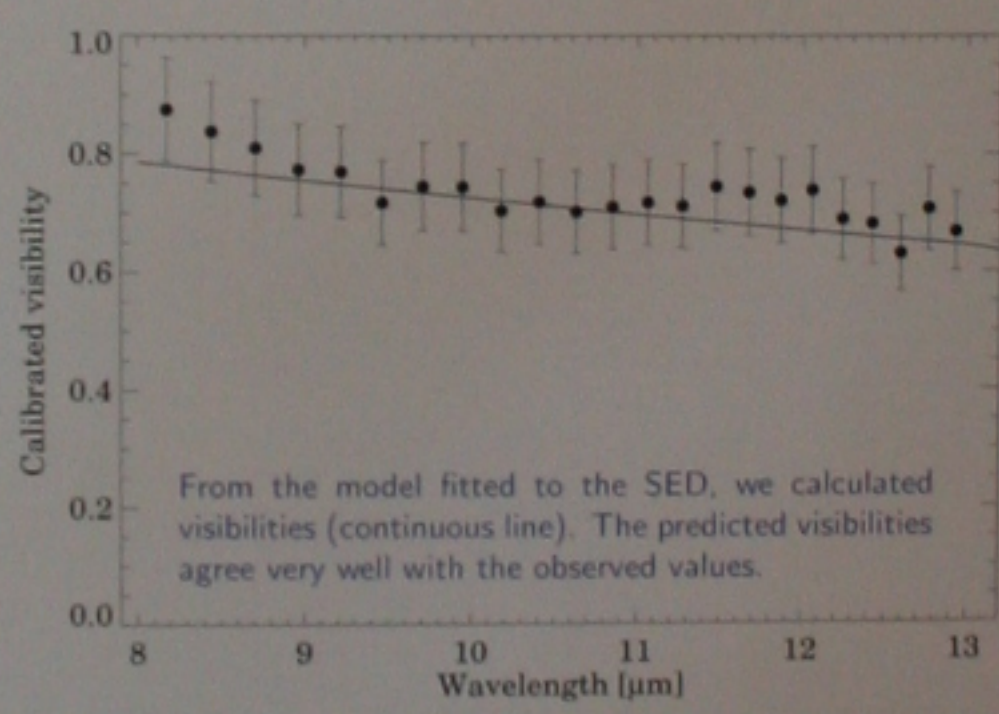
ANALYSIS: STEP 1 - FIT THE SED

We collected simultaneous observations from the whole optical-infrared-submillimetre wavelength regime. We fitted the spectral energy distribution (SED) with the sum of the spectra of a star and a geometrically flat, optically thick disc.



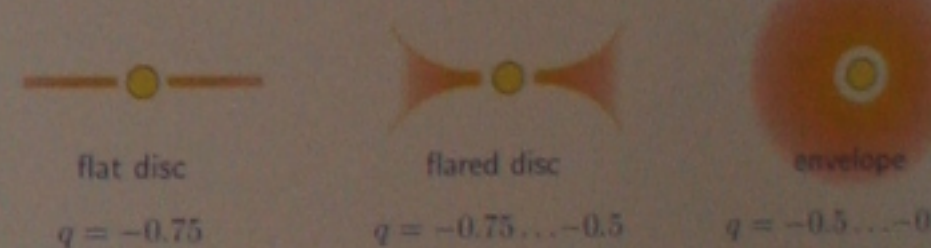
Model parameters:
 $R_d = 5$ AU
 $T(1 \text{ AU}) = 680$ K
 $T(r) \sim r^{-q}$ with $q = -0.53$
 $\Sigma(r) \sim r^{-p}$ with $p = -1.5$
 $M_d = 0.05 M_{\odot}$
 $A_V = 10$ mag
 $i = 60^{\circ}$

ANALYSIS: STEP 2 - PREDICT VISIBILITIES



From the model fitted to the SED, we calculated visibilities (continuous line). The predicted visibilities agree very well with the observed values.

ANALYSIS: TEMPERATURE DISTRIBUTIONS ($T \sim r^q$)



- V1647 Ori: $q = -0.53$, consistent with both the SED and the N-band visibilities (this work)
- FU Ori: $q = -0.71$, consistent with both the SED and the K-band visibilities (Malbet et al. 2005)
- V1057 Cyg and V1515 Cyg: $q = -0.45$ from the SED, $q = -0.65$ from the K-band visibilities (Millan-Gabet et al. 2006)
- Z CMa: $q = -0.75$, consistent with the SED but not with the K-band visibilities (Millan-Gabet et al. 2006)

MORE TO READ

The infrared properties of the new outburst star IRAS 05436-0007 in quiescent phase

P. Ábrahám¹, Á. Kóspál², Sz. Csizmadia¹, A. Moór¹, M. Kun¹, and G. Stringfellow³

A&A 419, L39-L42 (2004)

Long-term evolution of FU Orionis objects at infrared wavelengths*

P. Ábrahám¹, Á. Kóspál², Sz. Csizmadia¹, M. Kun¹, A. Moór¹, and T. Prusti³

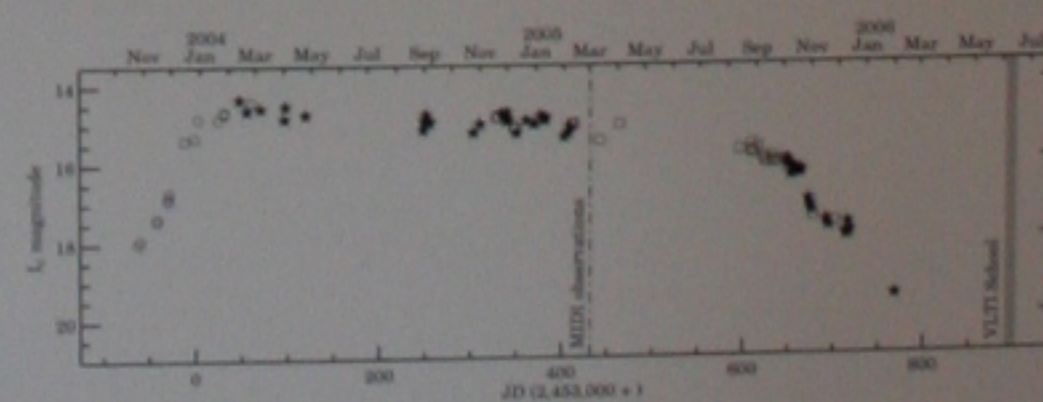
A&A 428, 89-97 (2004)

THE RAPID FADING OF V1647 ORIONIS: THE SUDDEN END OF A FUOR-TYPE ERUPTION?

KÓSPÁL, ÁGNES¹, ÁBRAHÁM, PÉTER¹, ACOSTA-PULIDO, JOSÉ², CSIZMADIA, SZILÁRD¹, ERDEKES, MÁRIA¹, KUN, MÁRIA¹, RÁCZ, MIKLÓS¹

INFORMATION BULLETIN ON VARIABLE STARS Number 5661

THE OUTBURST HISTORY OF V1647 ORI



A monitoring programme conducted at the Konkoly Observatory (Hungary) and at the Instituto de Astrofísica de Canarias (Spain) revealed that, after nearly 2 years in outburst, V1647 Ori went back to quiescent state by 2006.

REFERENCES

- Kenyon & Hartmann 1996, ARA&A 34, 207
Leinert et al. 2004, A&A 423, 537
Malbet et al. 2005, A&A 437, 627
Millan-Gabet et al. 2006, A&A 641, 547
Reipurth & Aspin 2004, ApJ 606, L119

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Astronomy Astrophysics

First AU-scale observations of V1647 Orionis with VLTI/MIDI*

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ABSTRACT. The young pre-main sequence star V1647 Ori was observed with MIDI, the mid-infrared interferometric instrument on the Very Large Telescope (VLT), in March 2005. We present the first interferometric visibility data for this object. The data show that the source is resolved. The fitted Gaussian sizes are: 6 mas (2.7 AU) at 8 μm , 16 mas (7.2 AU) at 13 μm . The temperature distribution is non-uniform: the inner part has higher temperature. We determined an upper limit for the brightness of a possible companion. No companion is detected at the measured position angle whose separation is less than 100 AU and brightness ratio to V1647 Ori is greater than 10%. The predicted visibilities agree very well with the observed values. From the model fitted to the SED, we calculated visibilities (continuous line). The predicted visibilities agree very well with the observed values.

Long-term evolution of FU Orionis objects at infrared wavelengths*

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ABSTRACT. We investigate the long-term evolution of FU Orionis objects in the 1–100 μm wavelength range using data collected by the Infrared Astronomical Satellite (IRAS) in 1983–1989. Most members of this class of stars are found to have a long-term evolution. The spectral energy distribution (SED) of these stars is well described by a model consisting of a star and a geometrically flat, optically thick disc. The model parameters are: $R_d = 5$ AU, $T(1 \text{ AU}) = 680$ K, $T(r) \sim r^{-q}$ with $q = -0.53$, $\Sigma(r) \sim r^{-p}$ with $p = -1.5$, $M_d = 0.05 M_{\odot}$, $A_V = 10$ mag, $i = 60^{\circ}$.

Astronomy Astrophysics

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