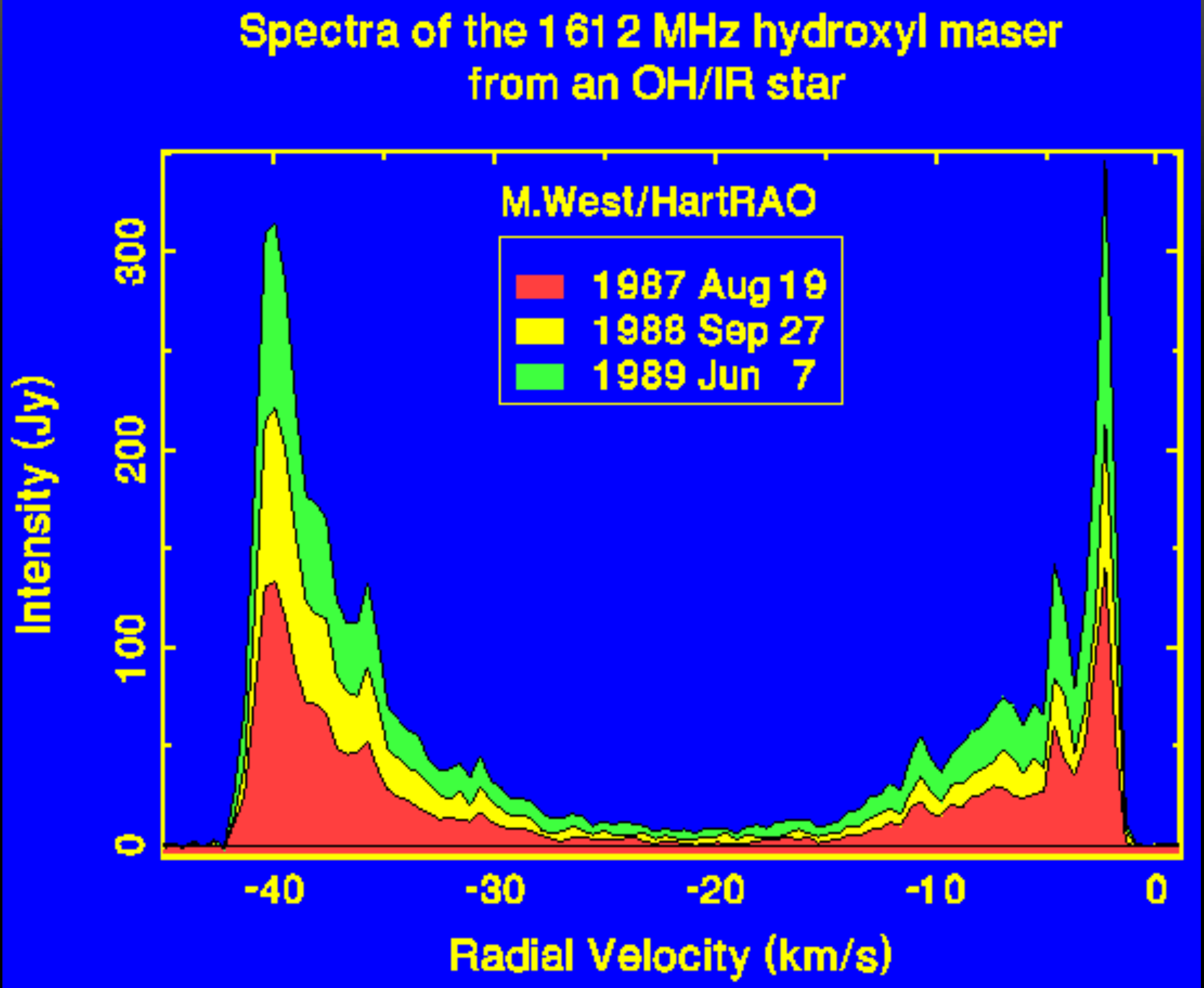
NEAL AS A MENTOR: LEARNING ABOUT FREE RADICALS

Steven Beckwith



Spectra of the 1612 MHz hydroxyl maser
from an OH/IR star
M.West/HartRAO
1987 Aug 19
1988 Sep 27
1989 Jun 7
Intensity (Jy)
0
100
200
300
-40
-30
-20
-10
0
Radial Velocity (km/s)

OH–IR STARS

Elitzur, Goldreich, & Scoville
1976, ApJ, 205, 384

OH POPULATION FLOW

ALL TRANSITIONS THIN

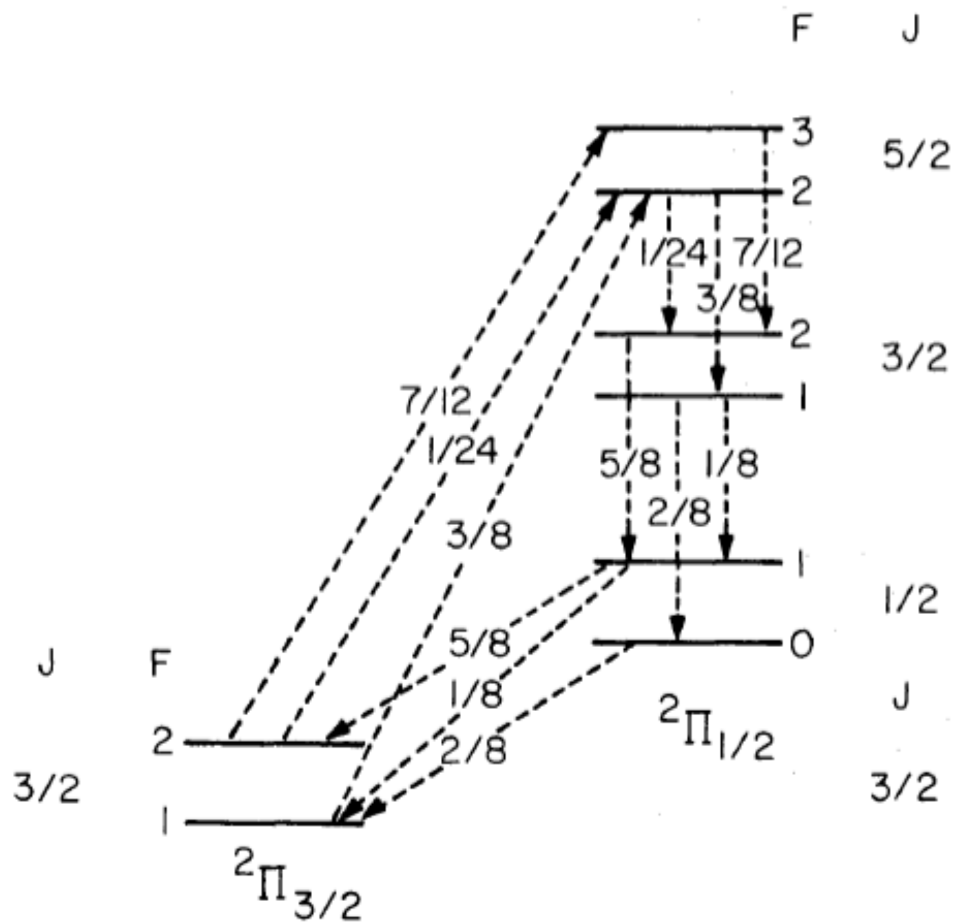


FIG. 2

TRANSITIONS TO GROUND STATE THICK

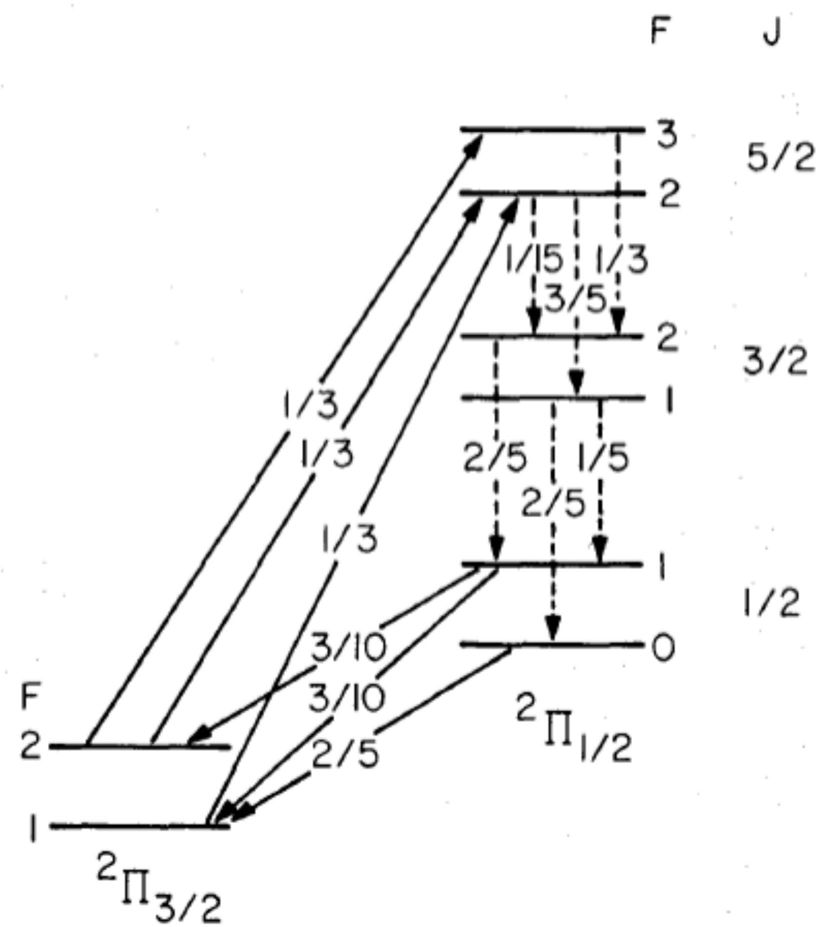
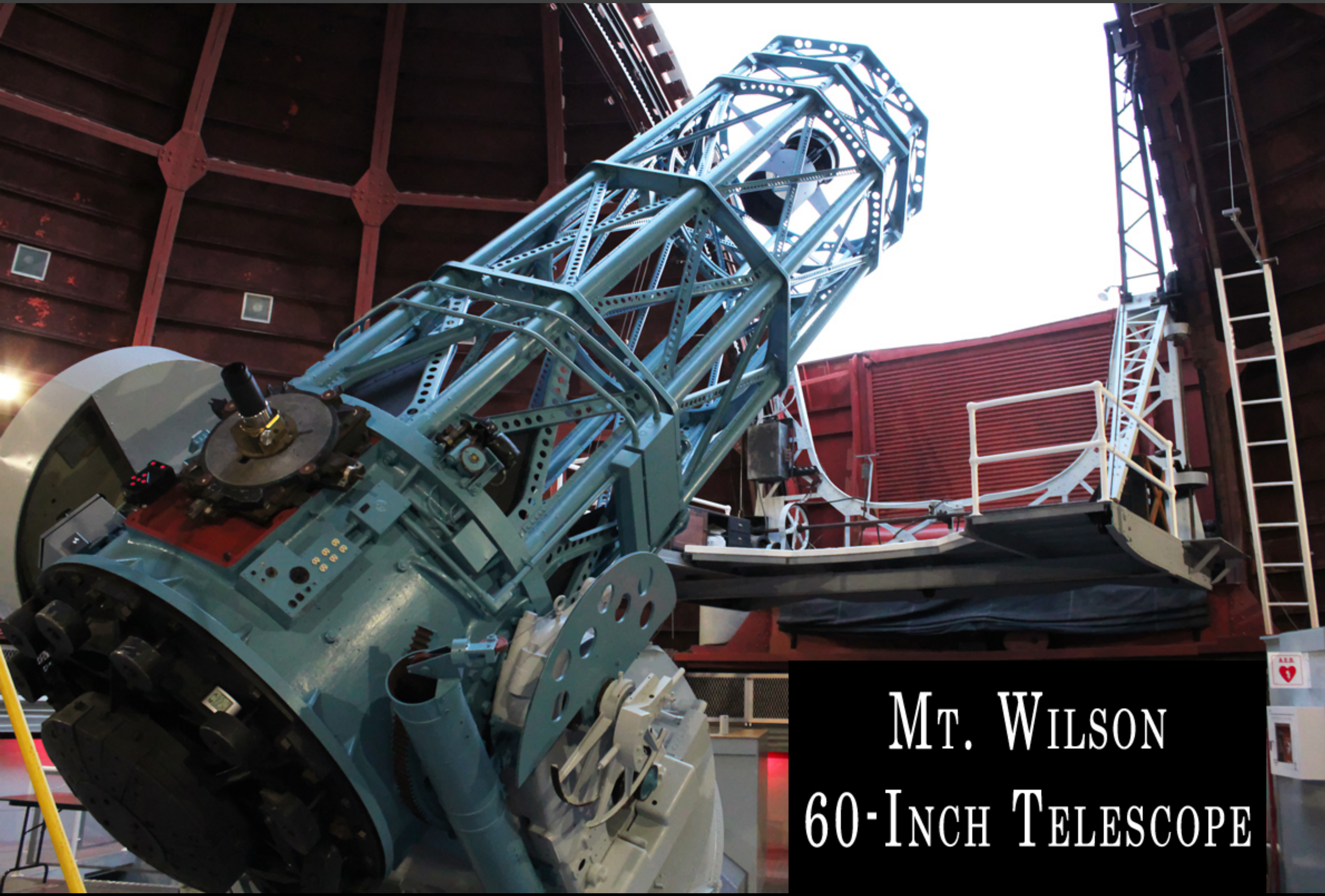
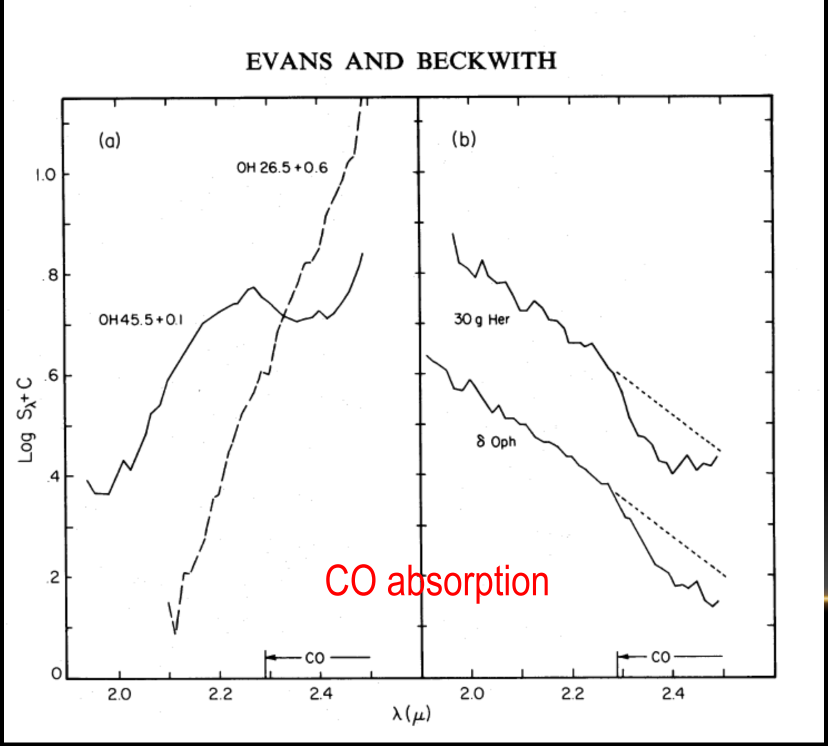


FIG. 3


Mt. Wilson
60-Inch Telescope

OH/IR STARS

- Radiative pump: correlated radio & infrared sources and flux densities
- Pumping: 2.8μm vs. 35μm (extrapolated)
- Stellar type: atmospheric CO
- PMS vs. evolved origins: mass loss



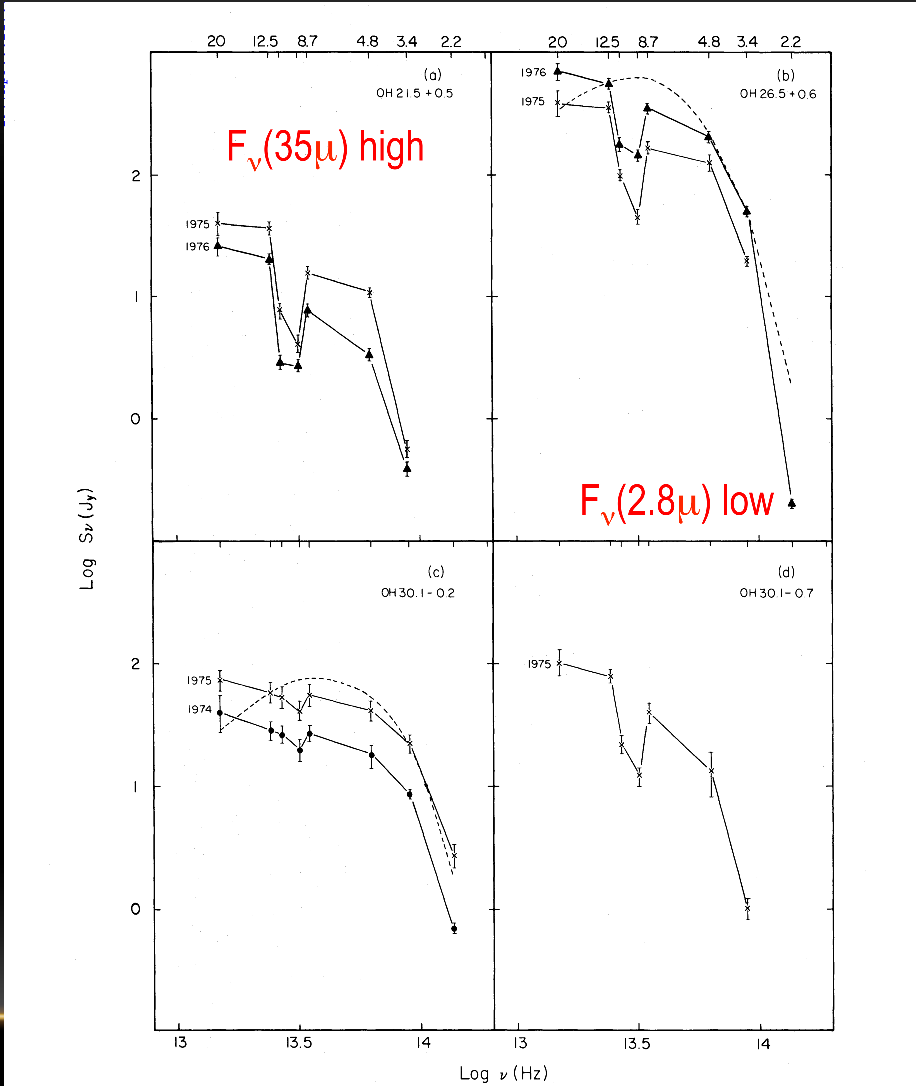


FIG. 1.—The infrared energy distributions of the new sources (*a*)–(*f*) and of two previously studied sources (*g*). The dashed lines in Figs. 1*b* and 1*c* are blackbody curves for the color temperature derived from the 12.5 and 3.4 μm measurements. Numbers at the top of the plots represent wavelength in microns.

SCIENCE & UNDERSTANDING

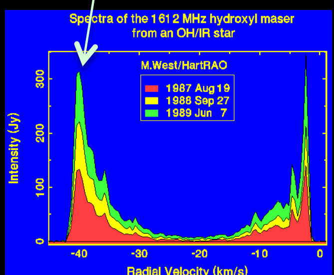
NEW INFRARED OBJECTS ASSOCIATED WITH OH MASERS

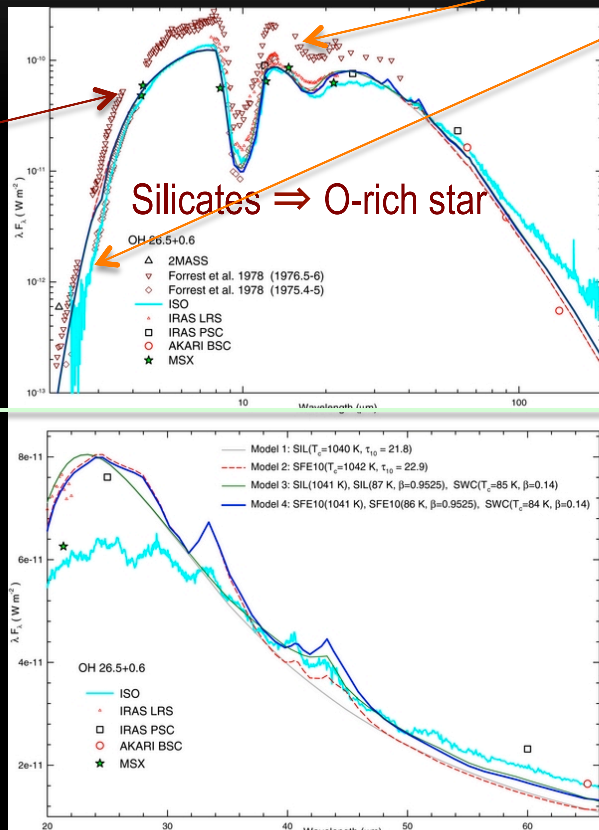
N. J. Evans II*†
Owens Valley Radio Observatory, California Institute of Technology, and
Department of Astronomy and McDonald Observatory, University of Texas at Austin
AND
S. Beckwith
Department of Physics, California Institute of Technology
Received 1977 February 14; accepted 1977 April 20

Strong 10μm, weak 3μm
⇒ 35μm pump radiation

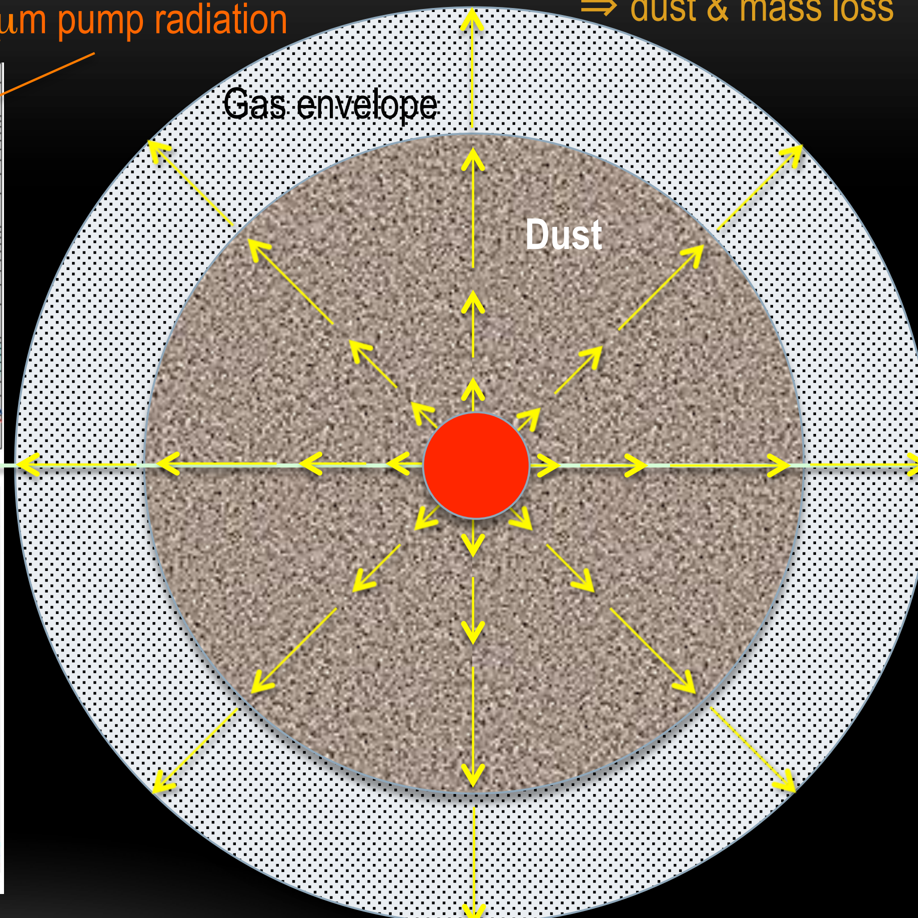
Infrared radiation
⇒ dust & mass loss

Radio/IR correlation
⇒ radiative pump





Silicates ⇒ O-rich star



OH line shape ⇒
radial amplification

6 OH = 6 IR stars
⇒IR radiative pump

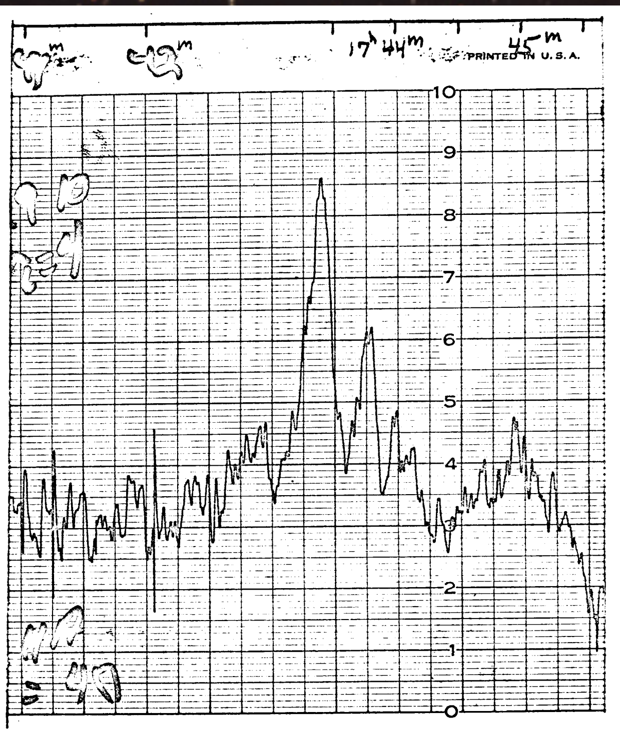
2.4μm CO absorption
⇒ cool supergiant atmosphere

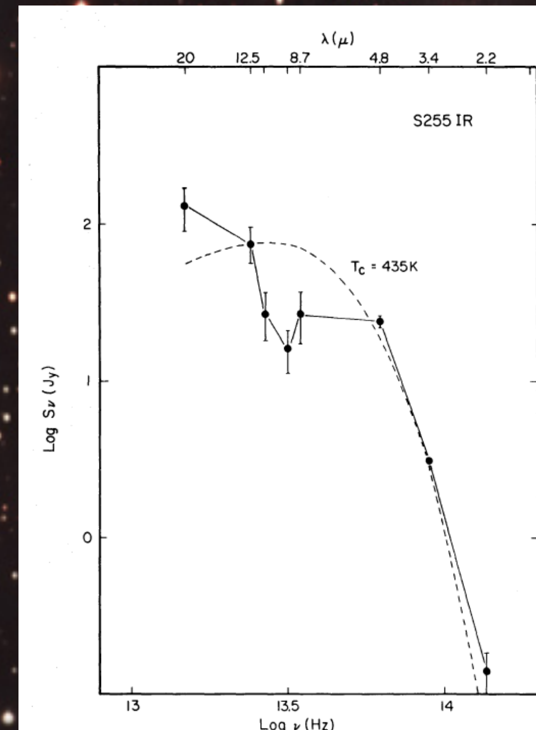
Radiative acceleration of envelope ~ r^2
⇒ v ~ constant at large r
⇒ radial amplification path

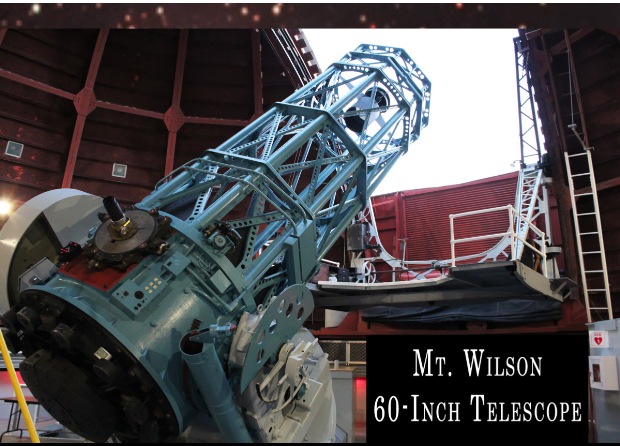
THE ENERGETICS OF MOLECULAR CLOUDS I. METHODS OF ANALYSIS AND APPLICATION TO THE S255 MOLECULAR CLOUD

N. J. Evans II, Guy N. Blair, and S. Beckwith

The Astrophysical Journal, **217**:448-463, 1977 October 15







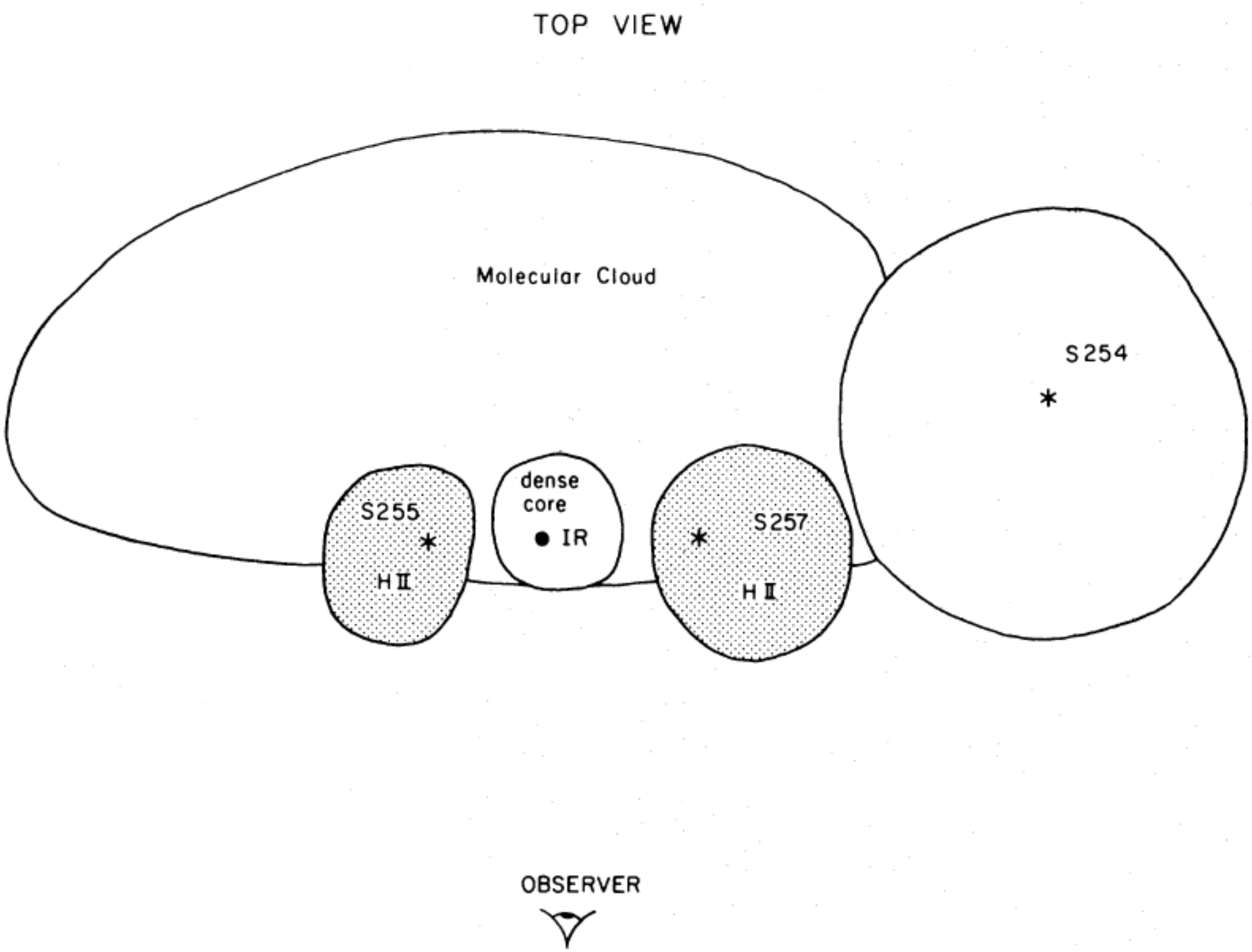
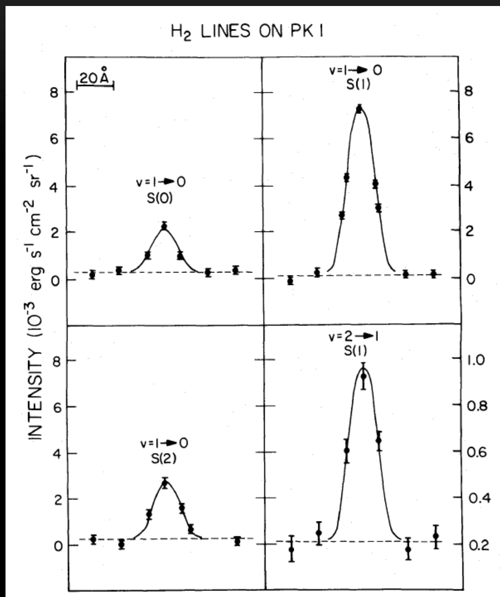
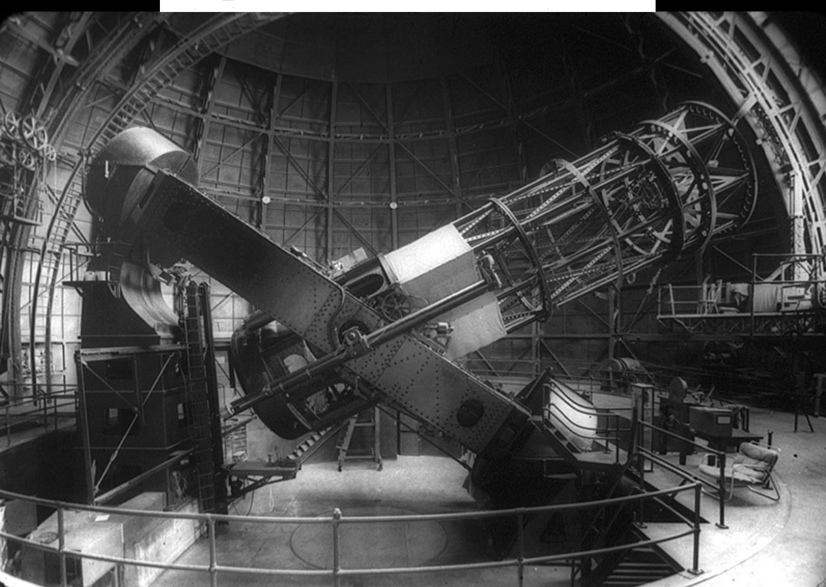
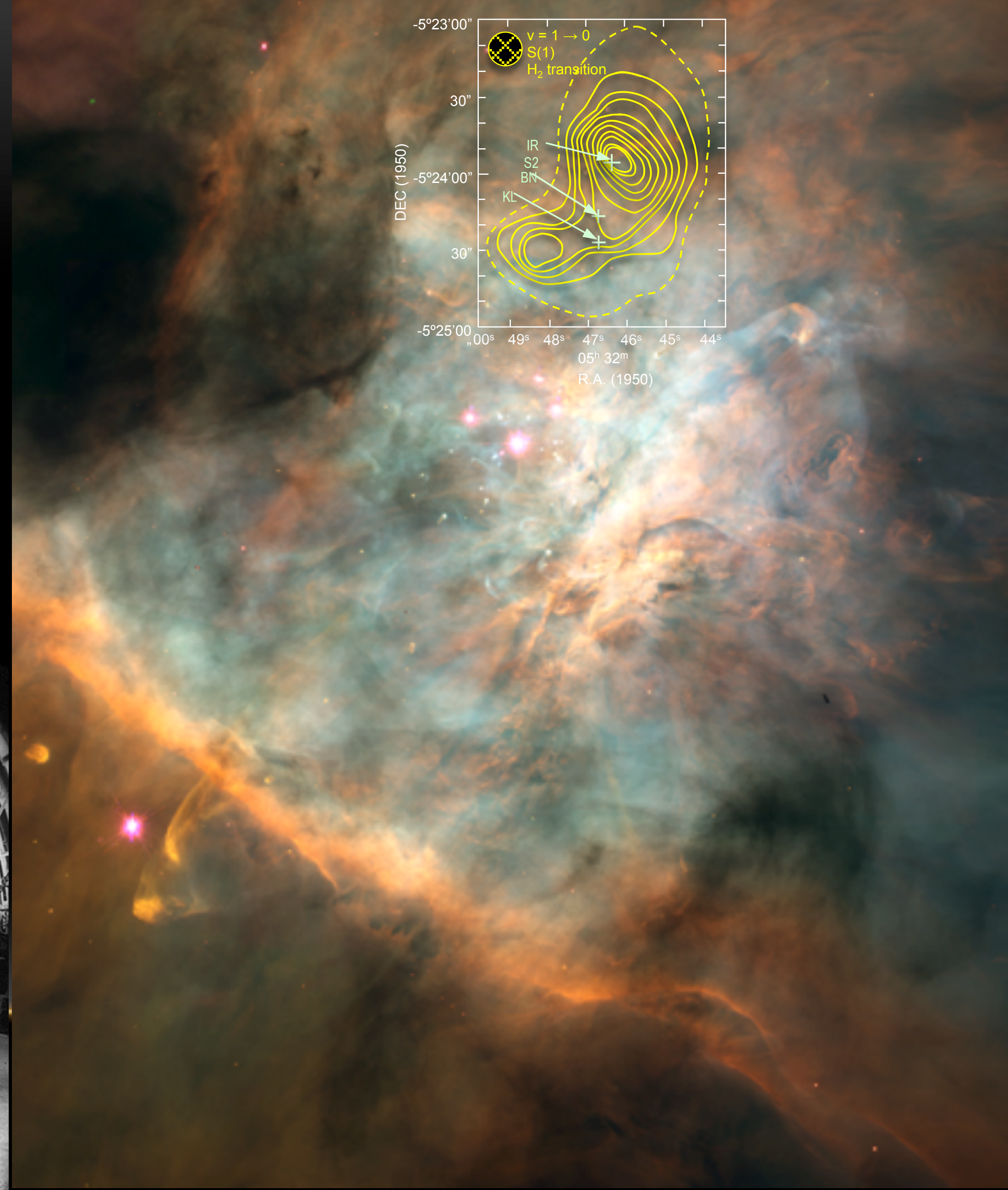


FIG. 7.—A schematic model of the molecular cloud–H II region. A top view is presented to illustrate the probable presence of dense gas between the two H II regions, S255 and S257, and the extension of the molecular cloud behind the two H II regions. The extent of the dense core back into the cloud and the location of the IR source along the observer line of sight are unknown; the portrayal of these features in this figure is arbitrary.

STAR FORMATION IN MOLECULAR CLOUDS: THE ORION NEBULA





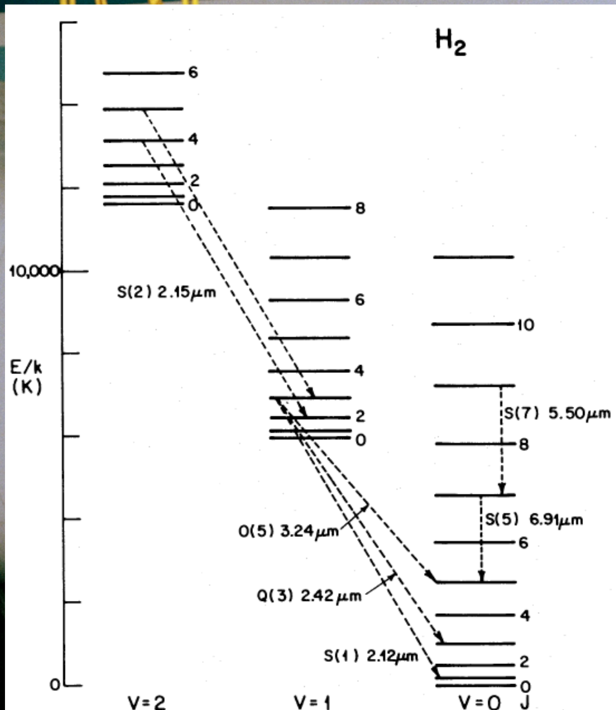


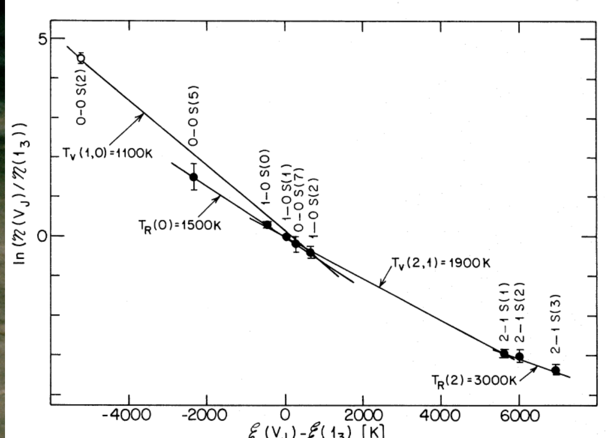

CUT HERE FOR
EMERGENCY RESCUE

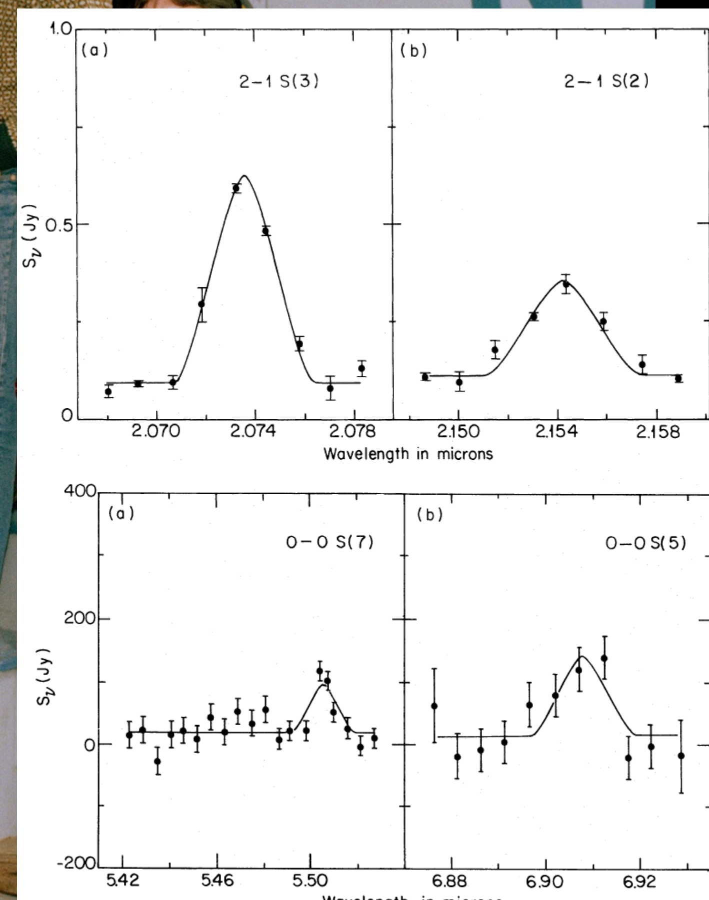
OBSERVATIONS OF THE EXTINCTION AND EXCITATION OF THE MOLECULAR HYDROGEN EMISSION IN ORION

S. BECKWITH,[1,2,3] NEAL J. EVANS II,[4] I. GATLEY,[5] G. GULL,[1] AND R. W. RUSSELL[1,6]

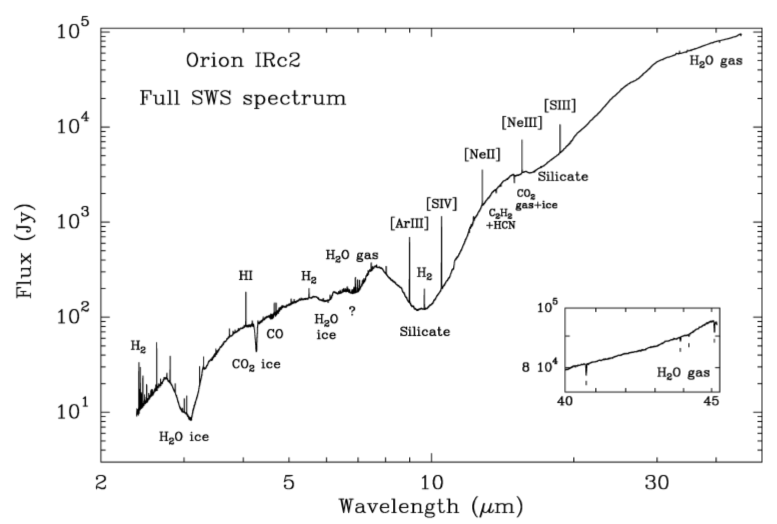
Received 1981 October 29; accepted 1982 June 24

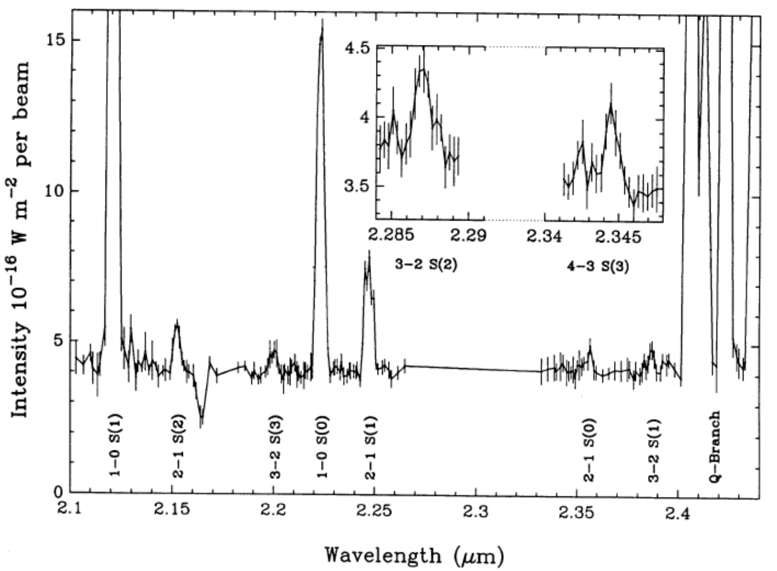




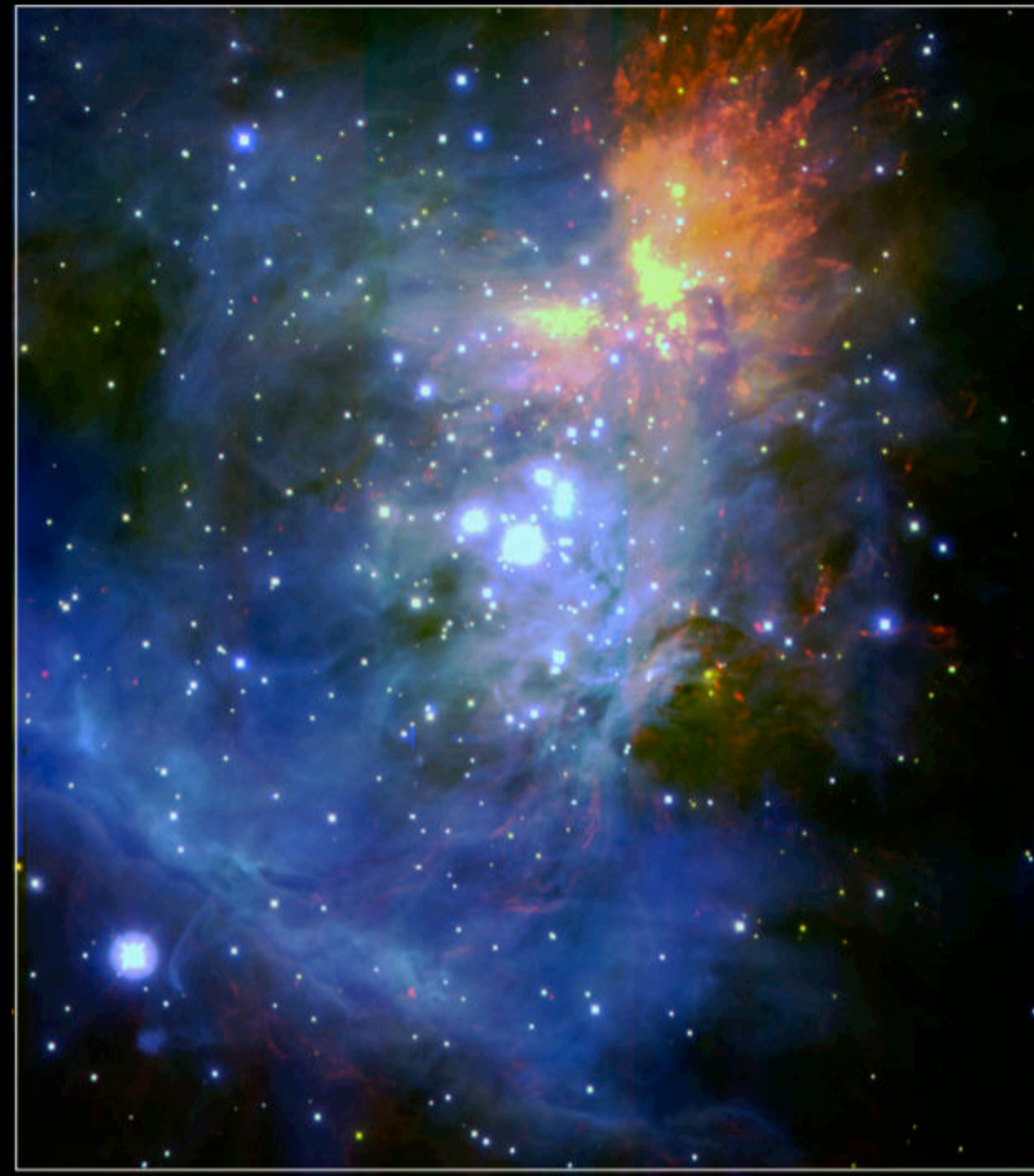


Van Dishoeck et al. 1998 *ApJL*, **502**, L173





Brand et al. 1988 *ApJL*, **334**, L103



Orion Nebula

CISCO (J, K′ & H_2 (v=1-0 S(1))

Subaru Telescope, National Astronomical Observatory of Japan

January 28, 1999

NEAR INFRARED OBSERVATIONS OF SHOCKED MOLECULAR HYDROGEN IN THE ORION MOLECULAR CLOUD

[Daniel Mark Olson], *San Jose State University*

Date of Award

Fall 2010

Degree Type

Thesis - Campus Access Only

Degree Name

Master of Science (MS)

Department

Physics

Advisor

Michael Kaufman

Keywords

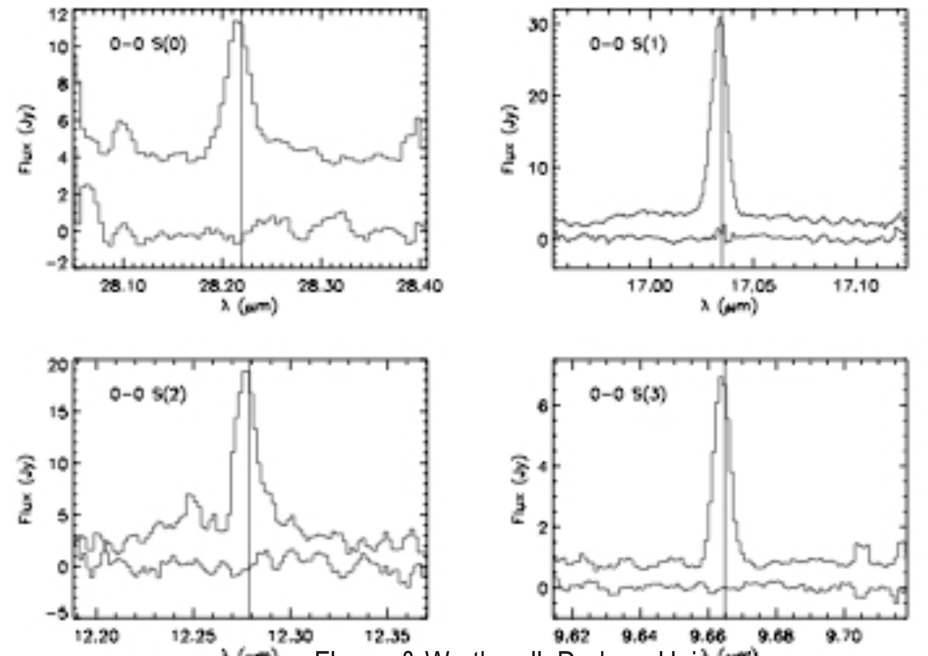
Infrared Astronomy, Molecular Clouds, Quantum, Shocked Regions, Star Formation

Subject Areas

Astronomy; Physics; Astrophysics

Abstract

Formation of massive stars is an area of active research. Like low mass stars, high mass stars go through a phase of accretion and outflow. High mass outflows are distinct from low mass outflows in that the former are poorly collimated and spread out into a butterfly pattern. The Orion outflow is composed of a large number of "bullet-shaped" shock waves. It is the nearest, best studied example of a massive outflow. High spectral and spatial resolution observations have been made at the United Kingdom Infrared Telescope (UKIRT) using an integral field unit (IFU) spectrometer. We use these data to study several bullets and derive energetics by comparing the data to detailed shock models. Temperatures and densities of the warm H2 gas are derived, and the masses of individual features are computed.

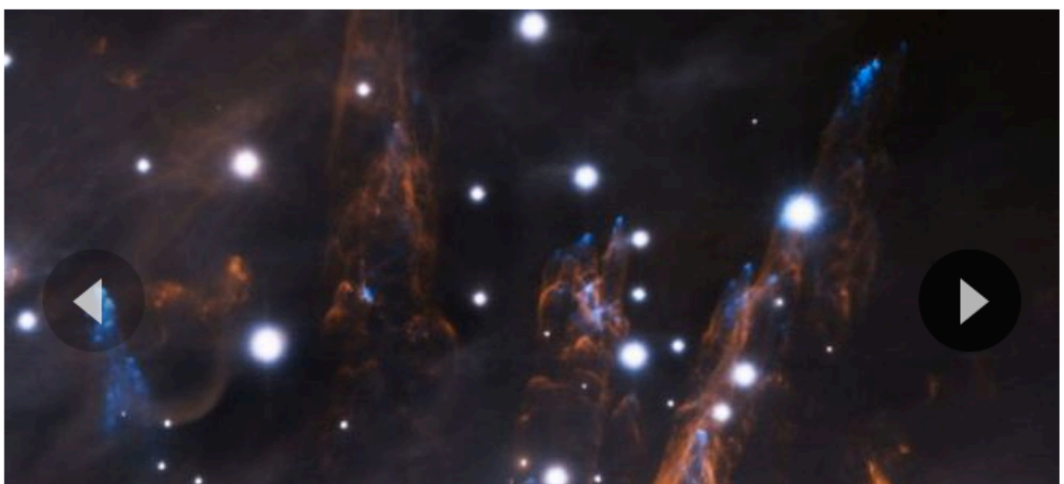


Flower & Wrathmall, Durham University

Gemini North press release, 3/22/07

Cosmic 'Bullets' Slam Orion Nebula in Dazzling Photo

By SPACE.com Staff / Published January 13, 2013 / Space.com



This image, obtained during the late commissioning phase of the GeMS adaptive optics system, with the Gemini South AO Imager (GSAOI) on the night of December 28, 2012, reveals exquisite details in the outskirts of the Orion Nebula. (GEMINI OBSERVATORY/AURA)

Astronomers have unveiled a spectacular new photo of cosmic "bullets" slicing through thick gas clouds at supersonic speeds in the famed Orion nebula.

The so-called Orion bullets are actually enormous clumps of gas packed with iron atoms, scientists said. They appear as distinctive blue features in the new image captured by the Gemini South Observatory in Chile.

Each cosmic bullet is about 10 times the size of Pluto's orbit around the sun, researchers said. Pluto is about 49 times farther from the sun than the Earth, which is only 93 million miles (150 million kilometers) away.

The new image, which scientists revealed on Wednesday (Jan. 9), was obtained on the night of Dec. 28 using a new adaptive optics system at the Gemini Observatory South telescope in Chile. The system is equipped with five laser guide stars and three deformable mirrors to correct image distortions from the Earth's atmosphere in real time, researchers said.

The result is a stunning view of the outer regions of the Orion nebula.

"For years our team has focused on developing this system, and to see this magnificent image, just hinting at its scientific potential, made our nights on the mountain — while most folks were celebrating the New Year's holiday — the best celebration ever!" Benoit Neichel, who leads this adaptive optics program for Gemini, said in a statement.

EARLY IMPACT: 1976-1985

THE ENERGETICS OF MOLECULAR CLOUDS. I. METHODS OF ANALYSIS AND APPLICATION TO THE S255 MOLECULAR CLOUD

N. J. EVANS II, GUY N. BLAIR, AND S. BECKWITH

THE ASTROPHYSICAL JOURNAL, 217:448-463, 1977 OCTOBER 15

116

FAR-INFRARED OBSERVATIONS OF THE CEPHEUS OB3 MOLECULAR CLOUD

N. J. EVANS II, E. E. BECKLIN, C. BEICHMAN, IAN GATLEY, R. H. HILDEBRAND, JOCELYN KEENE, M. H. SLOVAK, M. W. WERNER, AND S. E. WHITCOMB

THE ASTROPHYSICAL JOURNAL, 244:115-123, 1981 February 15

83

NEW INFRARED OBJECTS ASSOCIATED WITH OH MASER

N. J. EVANS II AND S. BECKWITH

THE ASTROPHYSICAL JOURNAL, 217:729-740, 1981 November 1

82

TYPE I OH MASERS: A STUDY OF POSITIONS, POLARIZATION, NEARBY WATER MASERS, AND RADIO CONTINUUM AND INFRARED PROPERTIES

N. J. EVANS II, S. BECKWITH, AND W. GILMORE

THE ASTROPHYSICAL JOURNAL, 227:450-465, 1979 January 15

62