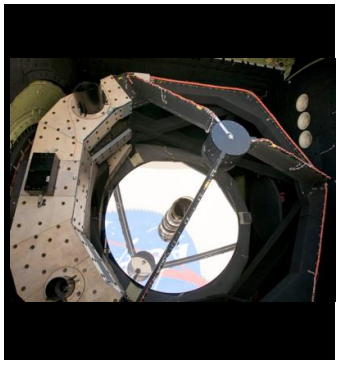
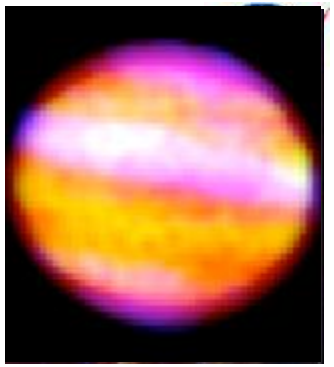
SOFIA Program Update

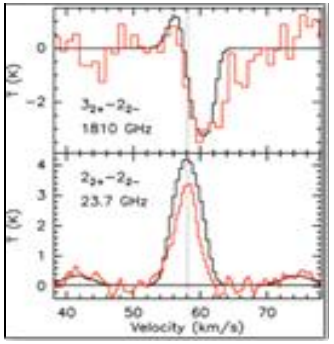
January 5, 2015

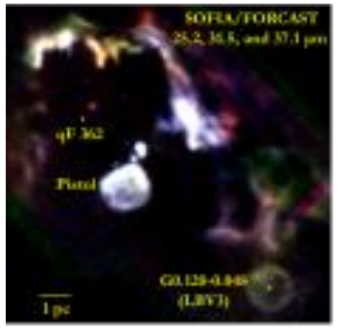
225th American Astronomical Society

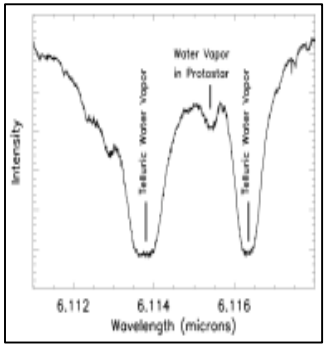
Pamela Marcum
NASA SOFIA Project Scientist

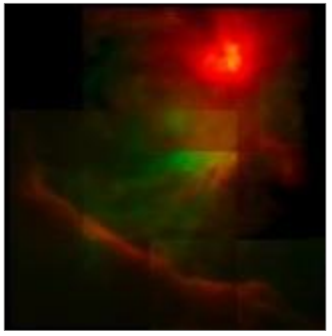


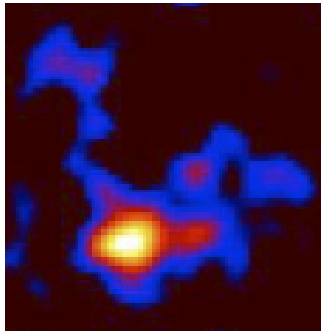












SOFIA
Stratospheric Observatory for Infrared Astronomy

- International partnership: 80% (U.S.) 20% (Germany)
- Global deployments including the Southern Hemisphere
- 7 science instruments available for competed community-led investigations

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1st Generation

	High speed photometry	Direct Imaging	Raster maps	Spectroscopy	Polarimetry	Operating Spectral Range (microns): optical	near-IR	mid-IR	far-IR
HIPO	✓					0.3-1.1			
FLITECAM	✓	✓		✓			1-5		
FORCAST		✓		✓				5-40	
EXES			✓	✓				5-28	
GREAT			✓	✓					60-240
FIFI-LS		✓		✓					40-210
HAWC+		✓		✓	✓				50-240
upGREAT			✓	✓					60-160

Status

- **Omnibus bill funds SOFIA at $70M (Dec 9, 2014)**
  - Represents a $17M (20%) cut to FY2015 operating budget
  - Impacts are being assessed to address this year's challenges
- **Aircraft returned to California from Heavy Maintenance Visit in Germany on December 14th**
  - Detailed inspections shows telescope to be in excellent condition, with no noticeable trace of wear or damage, and all systems performed without major findings
  - Aircraft is in excellent, "almost-new" condition
- **Observatory Systems and Next Generation Science Instrument status**
  - Ongoing cryo-cooler development for future instruments (e.g., upGREAT)
  - HAWC+ detector development going well; on-track for Jan 2016 commissioning
  - Newly-designed water vapor monitor installed on aircraft
- **All Cycle 1-2 data now fully processed and distributed to investigators**
  - Includes the previous backlog of FORCAST and FLITECAM grism data

Aircraft and Telescope Maintenance Visit

(Hamburg, Germany)

Find the hidden airplane

Ready to return home!

J-black coating in telescope cavity for long wavelength stray light control

Near-term Timeline of Major Activities

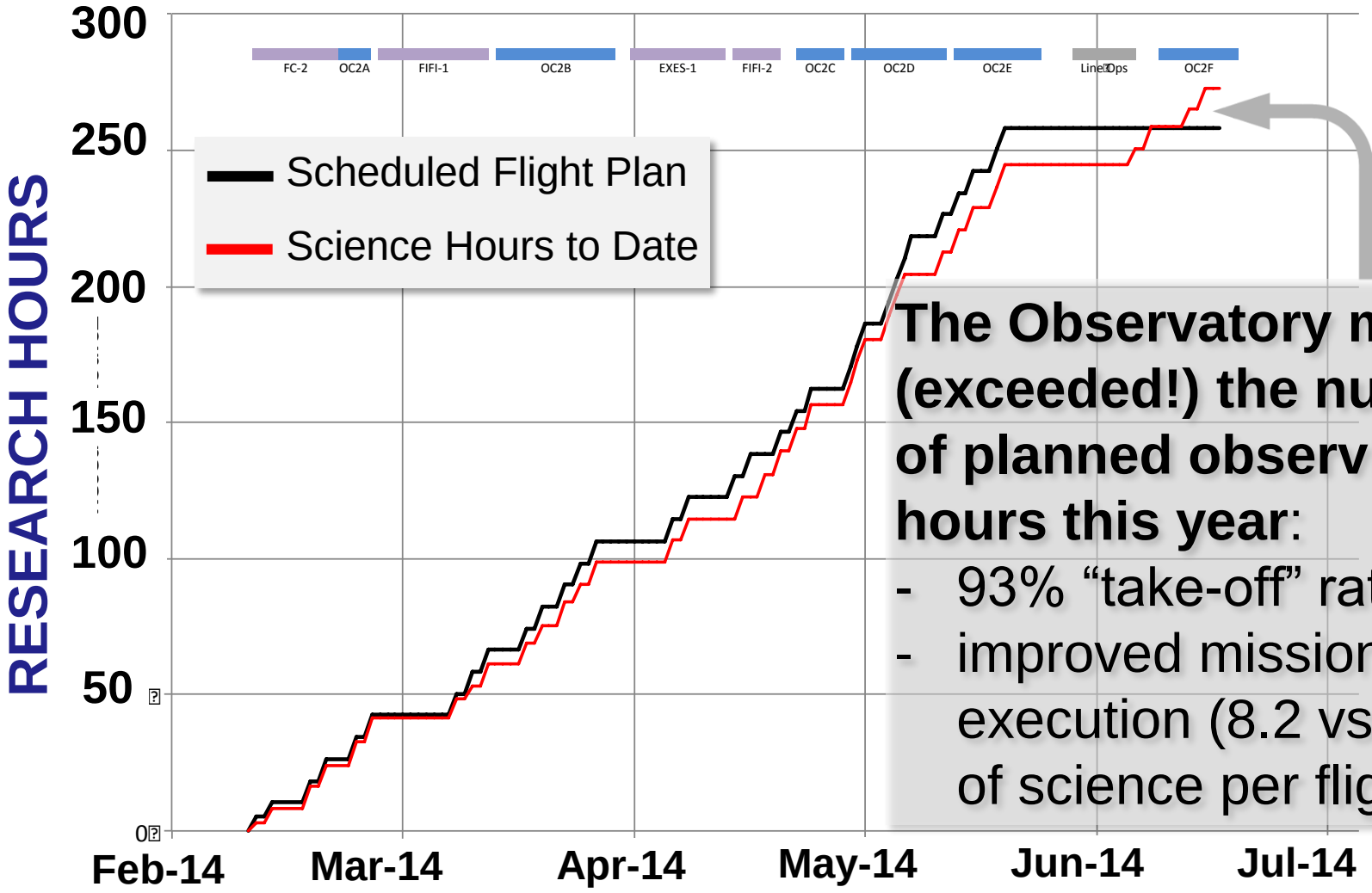
JANUARY	FEBRUARY	MARCH
Observatory functional checks	Complete EXES commissioning	Start Cycle 3 science flights (through Jan 2016)
Complete Cycle 2 science flights with FORCAST, GREAT, EXES		

All 1st-Generation Science Instruments fully commissioned!

MAY	JUNE	JULY
upGREAT science instrument commissioning	Southern Hemisphere deployment	

Cycle 2 Cumulative Research Hours

As of Jan 5, 2015



The Observatory met (exceeded!) the number of planned observing hours this year:

- 93% “take-off” rate
- improved mission execution (8.2 vs 8 hours of science per flight)

Published SOFIA Science 2014: Highlights

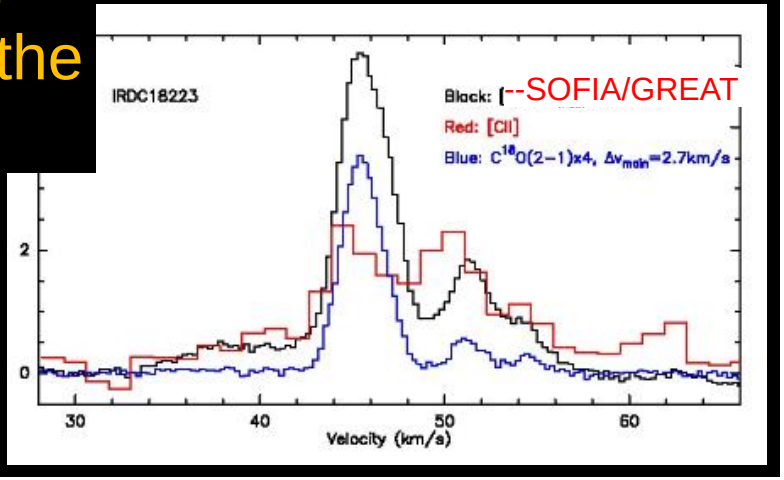
A&A 571, A53 (2014)

Carbon in different phases ([CII], [CI], and CO) in infrared dark clouds: Cloud formation signatures and carbon gas fractions *,**

H. Beuther[1], S. E. Ragan[1], V. Ossenkopf[2], S. Glover[3], Th. Henning[1], H. Linz[1], M. Nielbock[1], O. Krause[1], J. Stutzki[2], P. Schilke[2] and R. Güsten[4]

<u>Science Objective:</u> Reveal the cloud formation history that led to presently-observed protostars.

<u>The Approach:</u> In an idealized model, [CII], [CI] and CO trace the earliest to later dark cloud formation evolutionary stages, respectively. Comparison of velocity maps for these different carbon phase gases reveal embedded kinematic signatures imprinted during the earlier cloud formation process.



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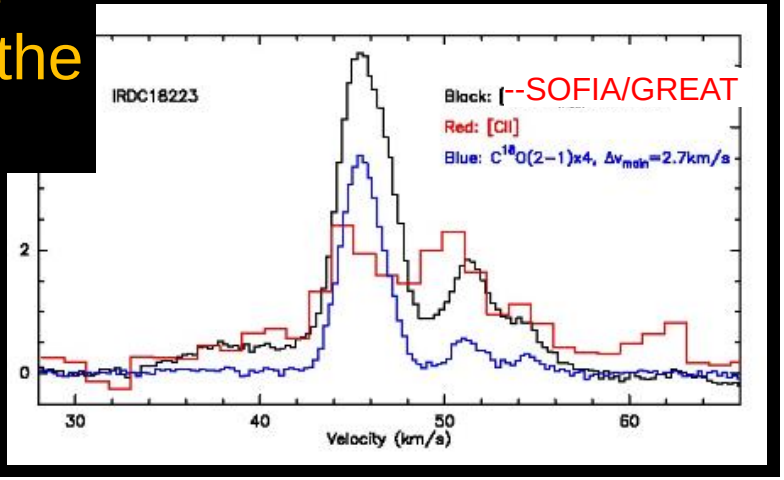
"SOFIA has now proven as a very efficient observatory to map clouds in the [CII] and other far-infrared spectral lines"



Published SOFIA Science 2014: Highlights

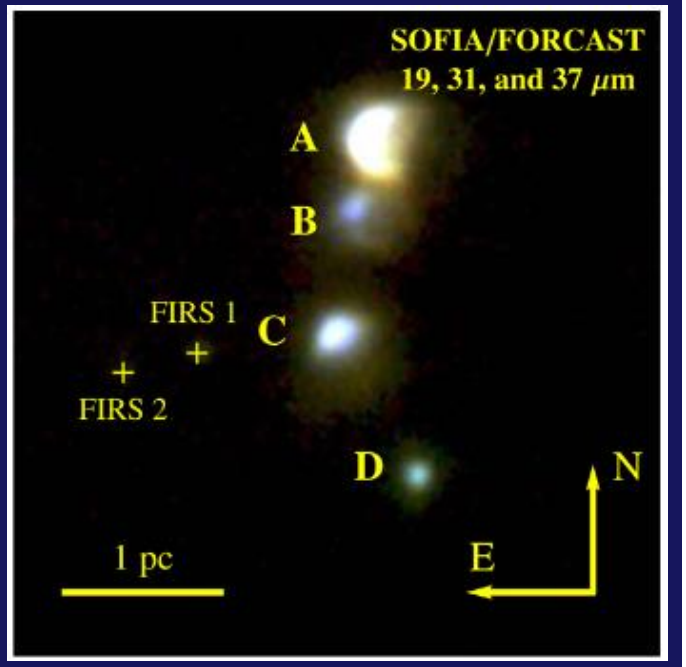
THE ASTROPHYSICAL JOURNAL, 794:108 (13pp), 2014 October 20 doi:10.1088/0004-637X/794

DUSTY CRADLES IN A TURBULENT NURSERY: THE SGR A EAST H II REGION COMPLEX AT THE GALACTIC CENTER

R. M. LAU[1], T. L. HERTER[1], M. R. MORRIS[2], AND J. D. ADAMS[1,3]

Science Question: Are massive stars preferentially formed from the molecular clouds inhabiting the extreme environment of Galactic Center?

This Study: SED/dust modelling revealed the nature of the heating sources as well as the mass of emitting dust:



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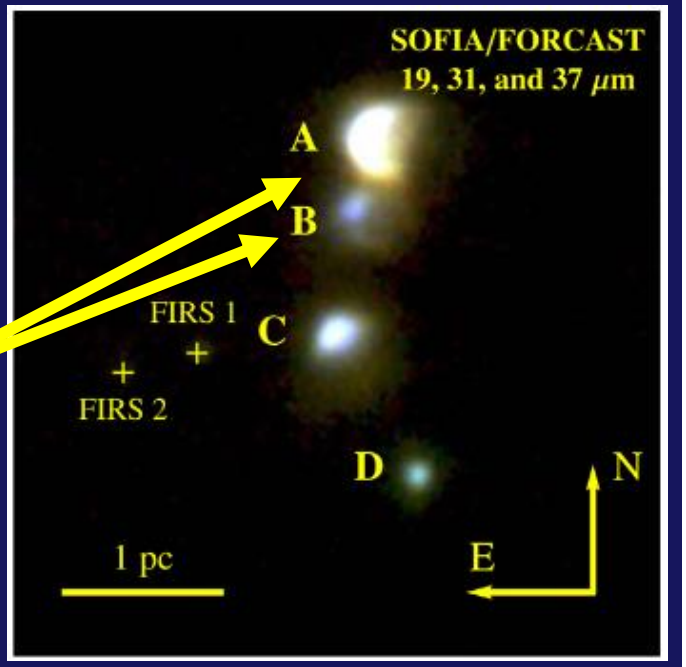
- Verified that sources are single (O6) stars. (spectral types are earlier than previously estimated via Lyman continuum flux)



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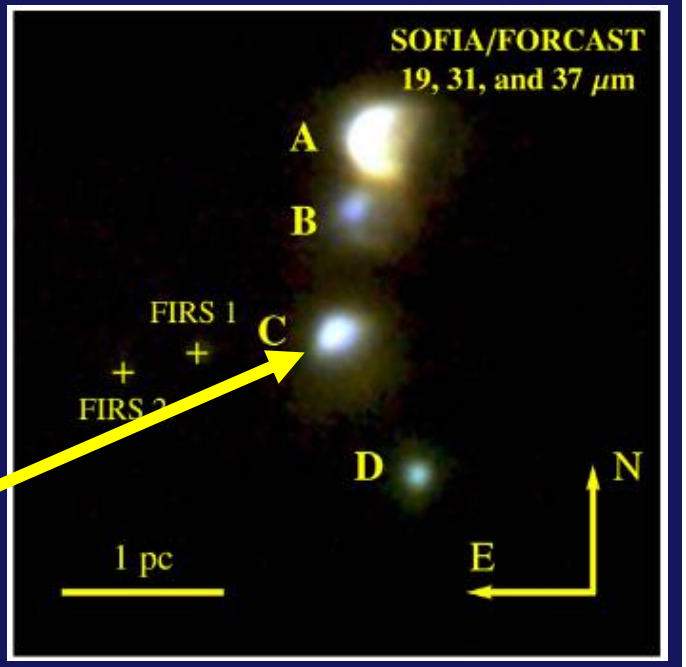
~ten late O-stars required to match dust temperature and Lyman continuum flux



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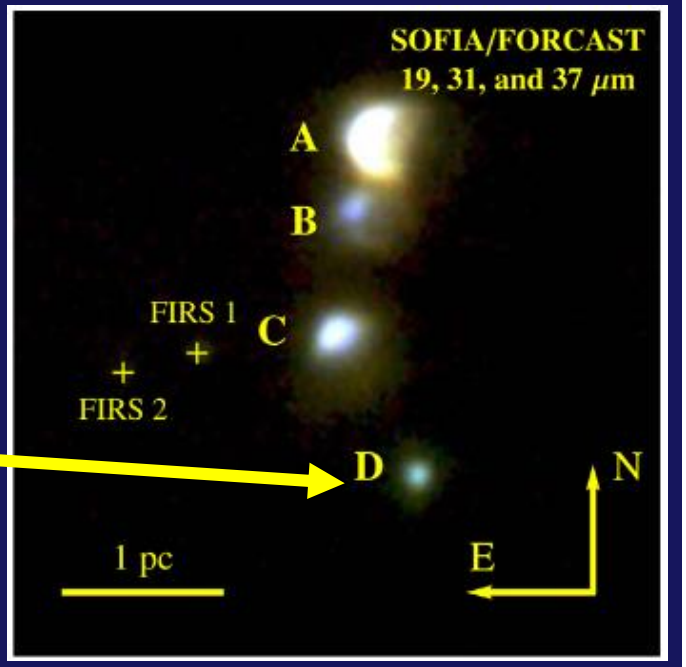
R. M. Lau[1], T. L. Herter[1], M. R. Morris[2], and J. D. Adams[1,3]

Science Question: Are massive stars preferentially formed from the molecular clouds inhabiting the extreme environment of Galactic Center?

This Study: SED/dust modelling revealed the nature of the heating sources as well as the mass of emitting dust:

- nearby prominent NIR point source previously attributed to the HII region is likely a coincidental line-of-sight alignment that is confused with emission of actual heating source.



Published SOFIA Science 2014: Highlights

H_2D^+ observations give an age of at least one million years for a cloud core forming Sun-like stars

***Nature*, November 17, 2014**

Sandra Brünken, Olli Sipilä, Edward T. Chambers, Jorma Harju, Paola Caselli, Oskar Asvany, Cornelia E. Honingh, Tomasz Kamiński, Karl M. Menten, Jürgen Stutzki & Stephan Schlemmer

Surprise discovery! Combined SOFIA and ground-based sub-mm observations of a star forming cloud show that the *collapse of dense cores leading to the formation of solar-mass stars* ***is much slower*** *than free-fall timescales* (1+ Myr vs ~100,000 yr)

The details: In cold (<20K) clouds, the conversion from ortho-to-para forms of the deuterated trihydrogen cation (H_2D^+) is dominated by proton-exchange chemical reactions with the ortho and para isomers of molecular hydrogen → the rate of ortho-to-para-H_2D^+ conversion is strongly coupled to the kinetic temperature of the molecular gas.

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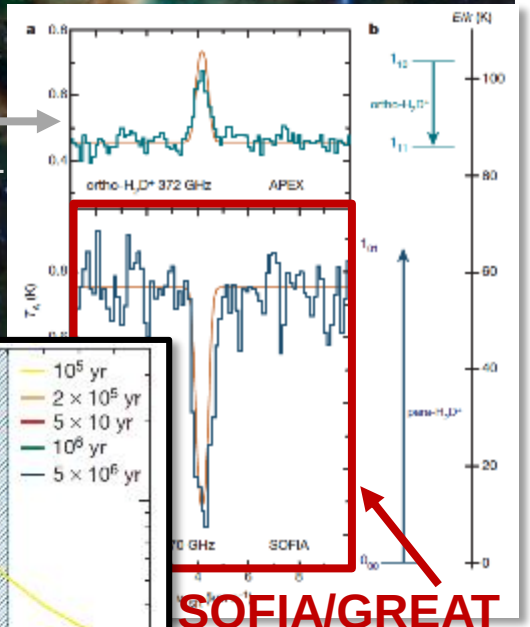
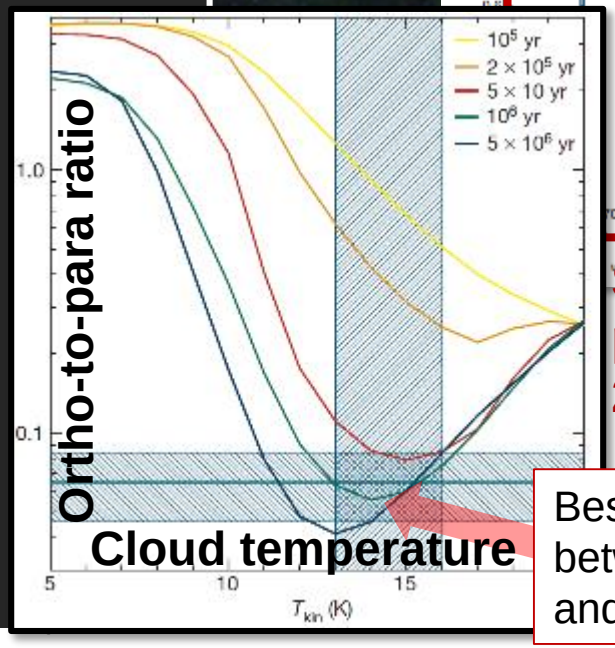
The details: The ortho/para ratio of the deuterated trihydrogen cation (H_2D^+) provided a chemical "clock" used to determine the 1+ Myr age of this star-forming cloud.

APEX: ortho-H_2D^+ 806µm



SOFIA/GREAT para-H_2D^+ 219µm



Best-fit to data: between $5x10^5$ and $5x10^6$ yrs