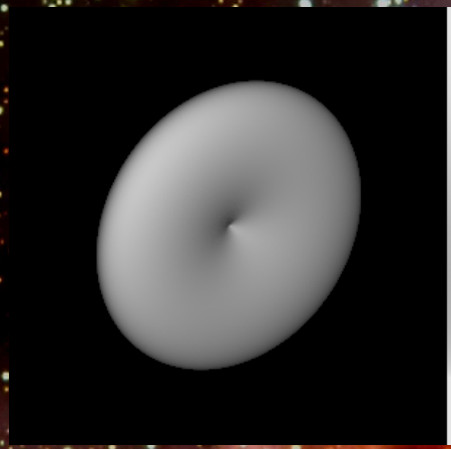
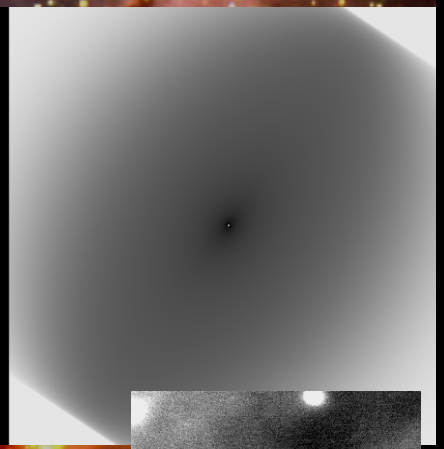
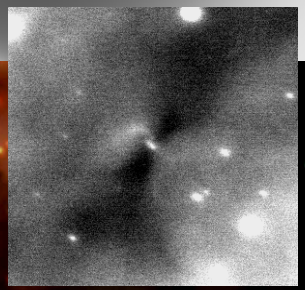
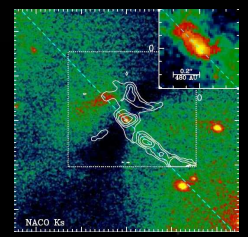
Evidence for Disks around YMSs from 3D Radiative Transfer Modeling

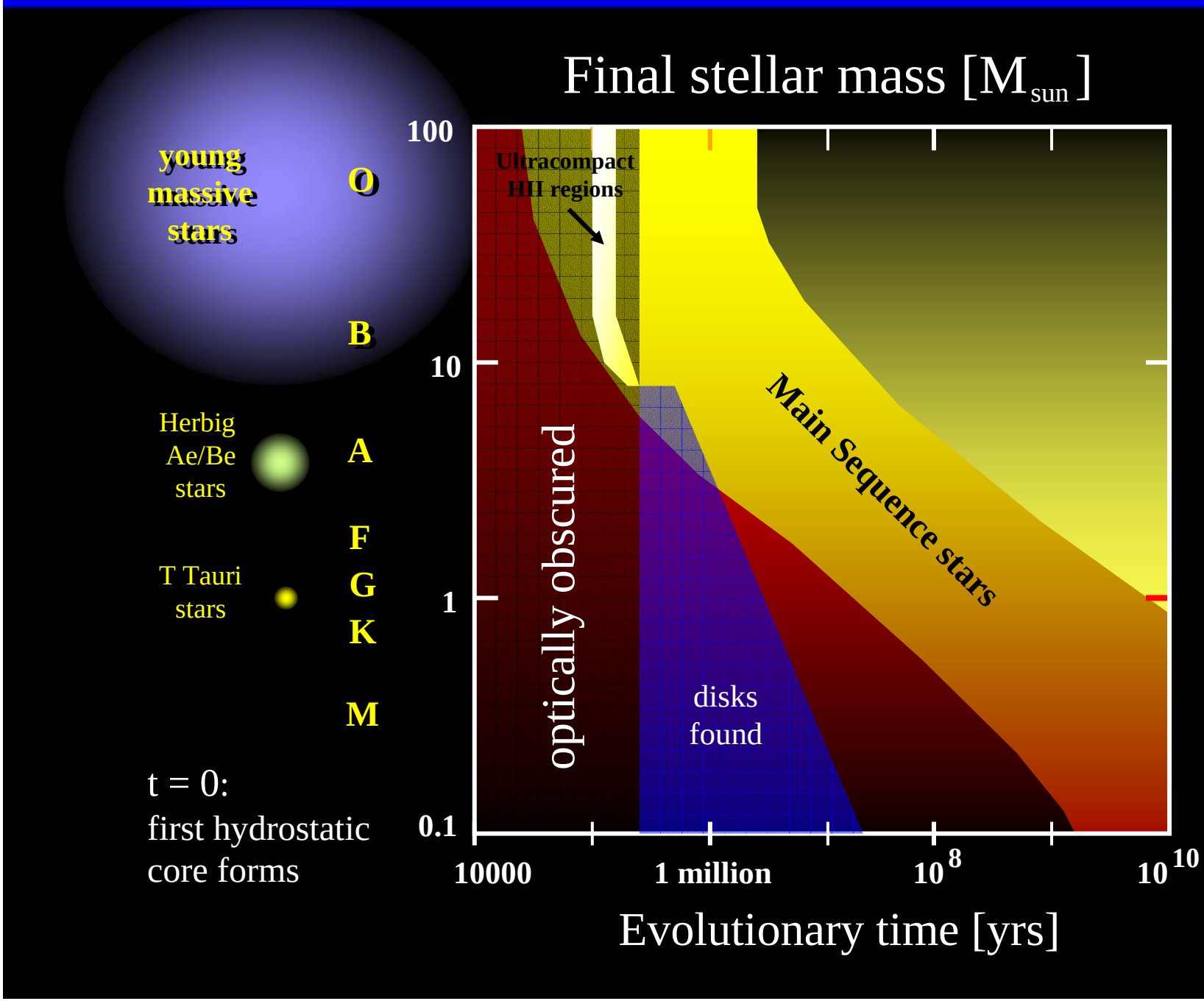
Jürgen Steinacker
Max-Planck-Institute for Astronomy Heidelberg (MPIA)
Institute for Computational Astronomy
at the Center for Astronomy Heidelberg (ZAH)



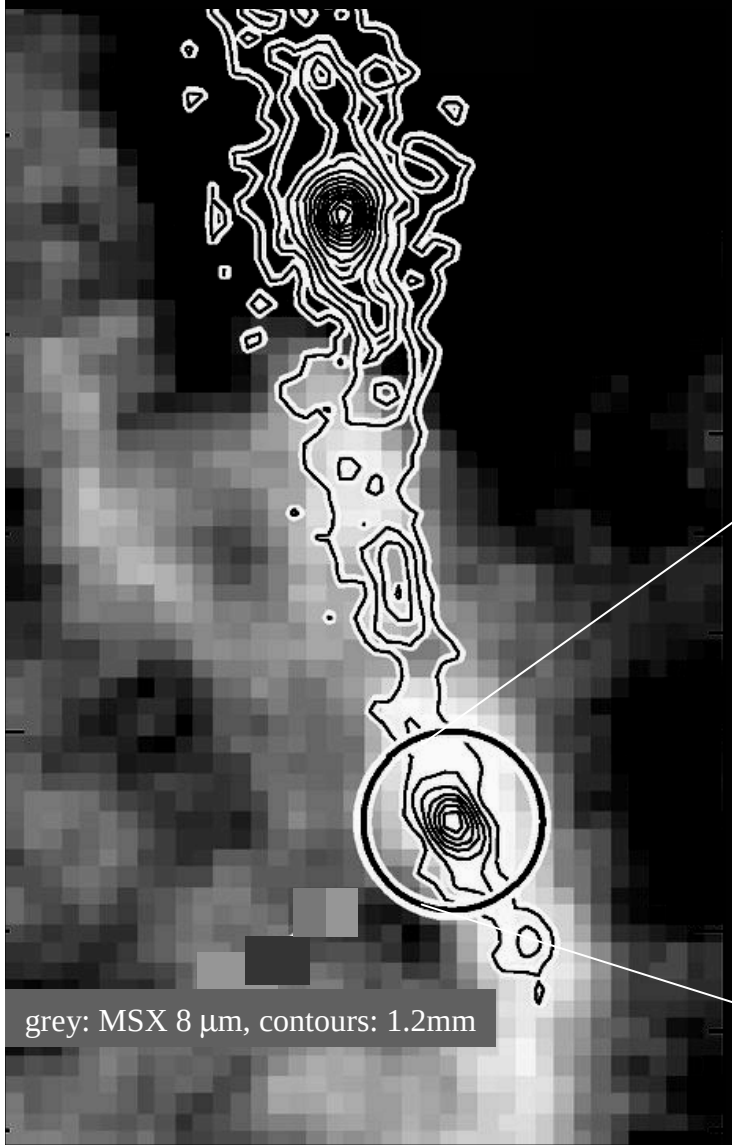



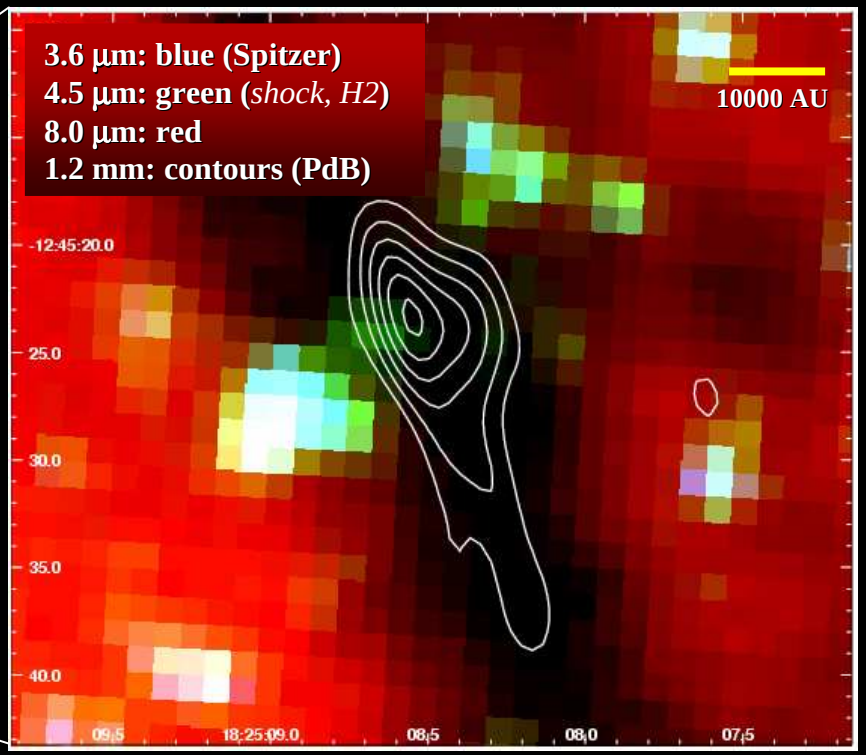
Massive Star Formation: Observation confront Theory, Heidelberg, Germany, 11 September 2007


young massive stars
O
B
A
F
G
K
M
Herbig Ae/Be stars
T Tauri stars
t = 0: first hydrostatic core forms
Final stellar mass [M sun]
100
10
1
0.1
Ultracompact HII regions
optically obscured
Main Sequence stars
disks found
10000
1 million
10 8
10 10
Evolutionary time [yrs]
after H.Yorke

Steinacker & Beuther 2006



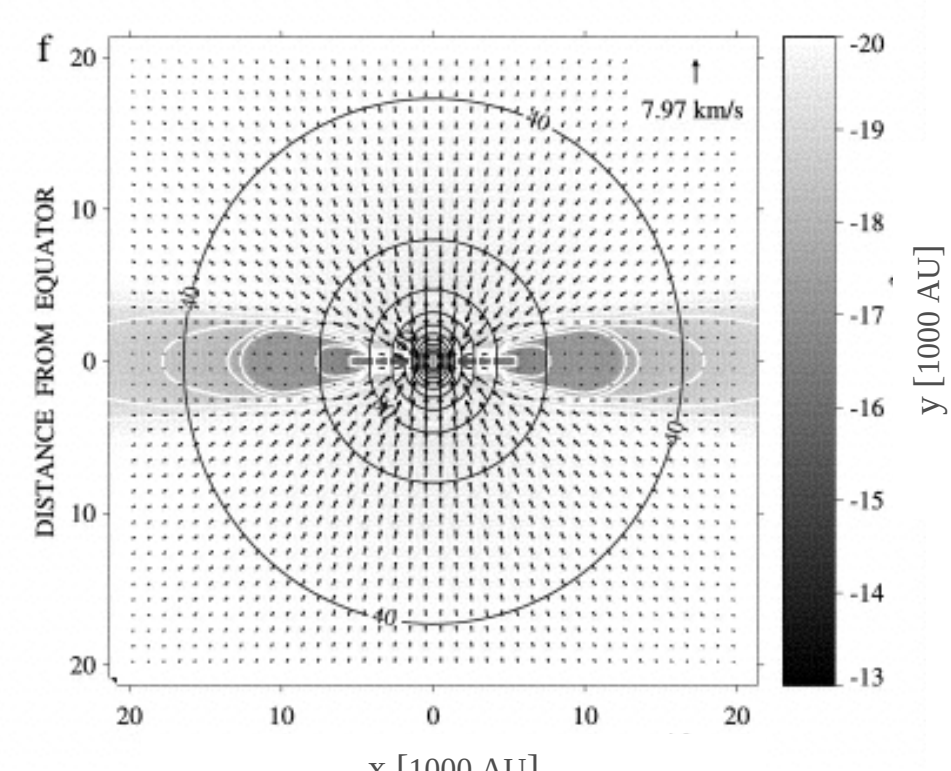
IRDC 18223-3



Disks in HD simulations

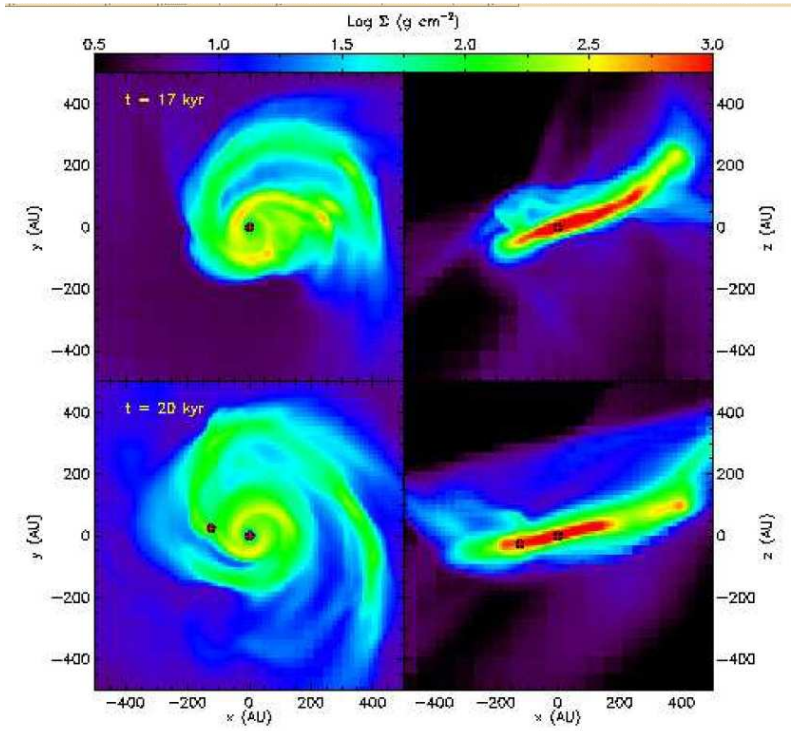
Yorke & Sonnhalter 2002

2D HD + λ-dependent RT



Krumholz, Klein & McKee 2006
ORION MHD AMR

3D HD + flux-limited diffusion

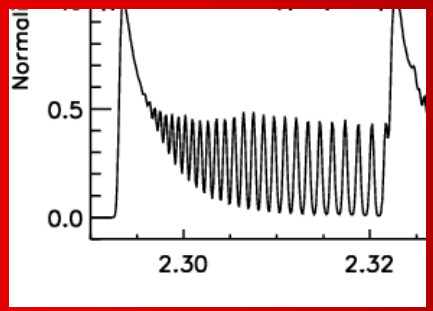


Observing a massive disk candidate

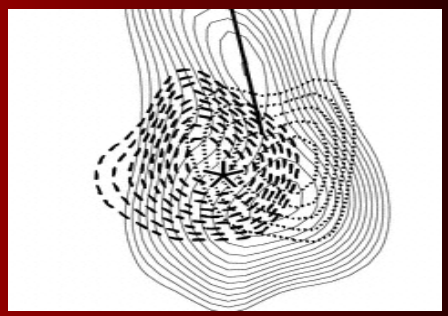
	Opt.	NIR	MIR	FIR	mm λ
Spatial Resolution:	0.1 kAU		kAU		few kAU
Continuum:	n(r,z) scattering		n(r) T(r)		total disk mass M_d disk extend r_o n(r,z) T(r,z)
Lines:	accretion sign. stellar mass, jets morphology	inner velocity field disk/stellar mass n(r,z) T(r,z) v(r,z)			outer velocity field disk/stellar mass, jets n(r,z) T(r,z) v(r,z)

SO-1 K-band
Chini et al. 2004
Steinacker et al. 2006
> 5 Msun 2.4 kpc

IRAS 11097-6102 CO bandhead
Bik & Thi 2004
11 Msun 2.8 kpc

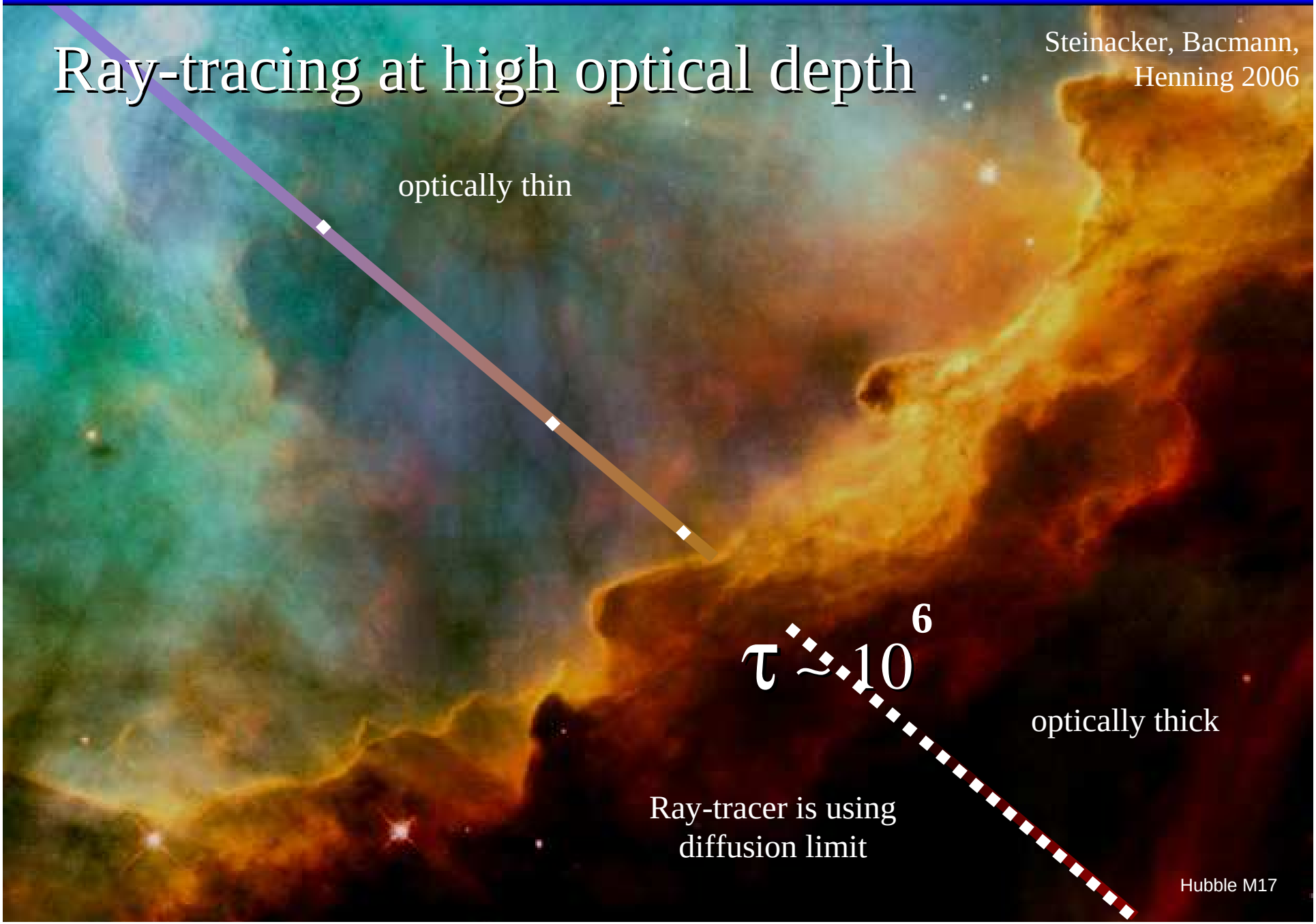


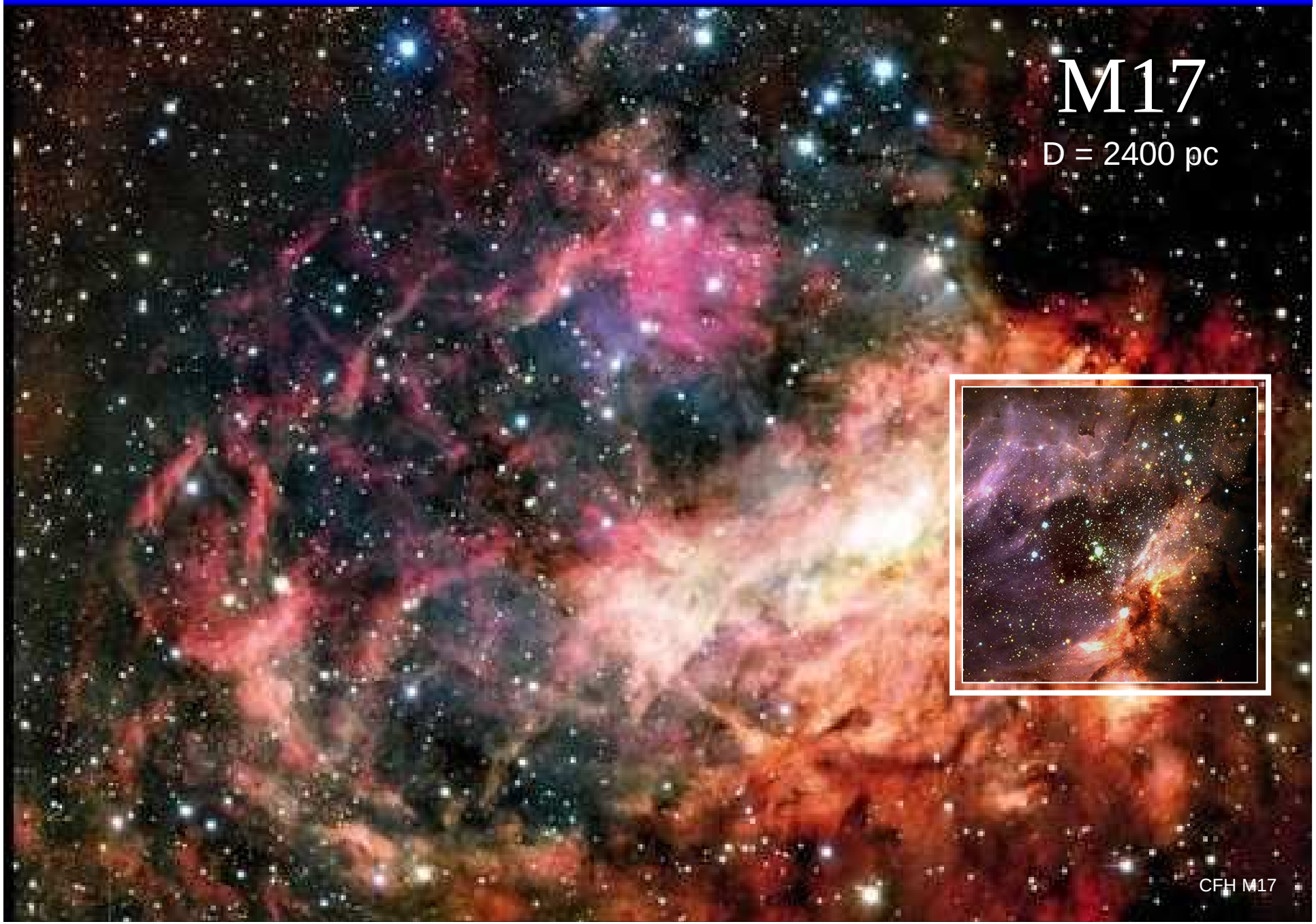
HCOOCH3 in IRAS 18089-1732
Beuther, Zhang, Sridharan, Chen 2005
16 Msun 3.6 kpc

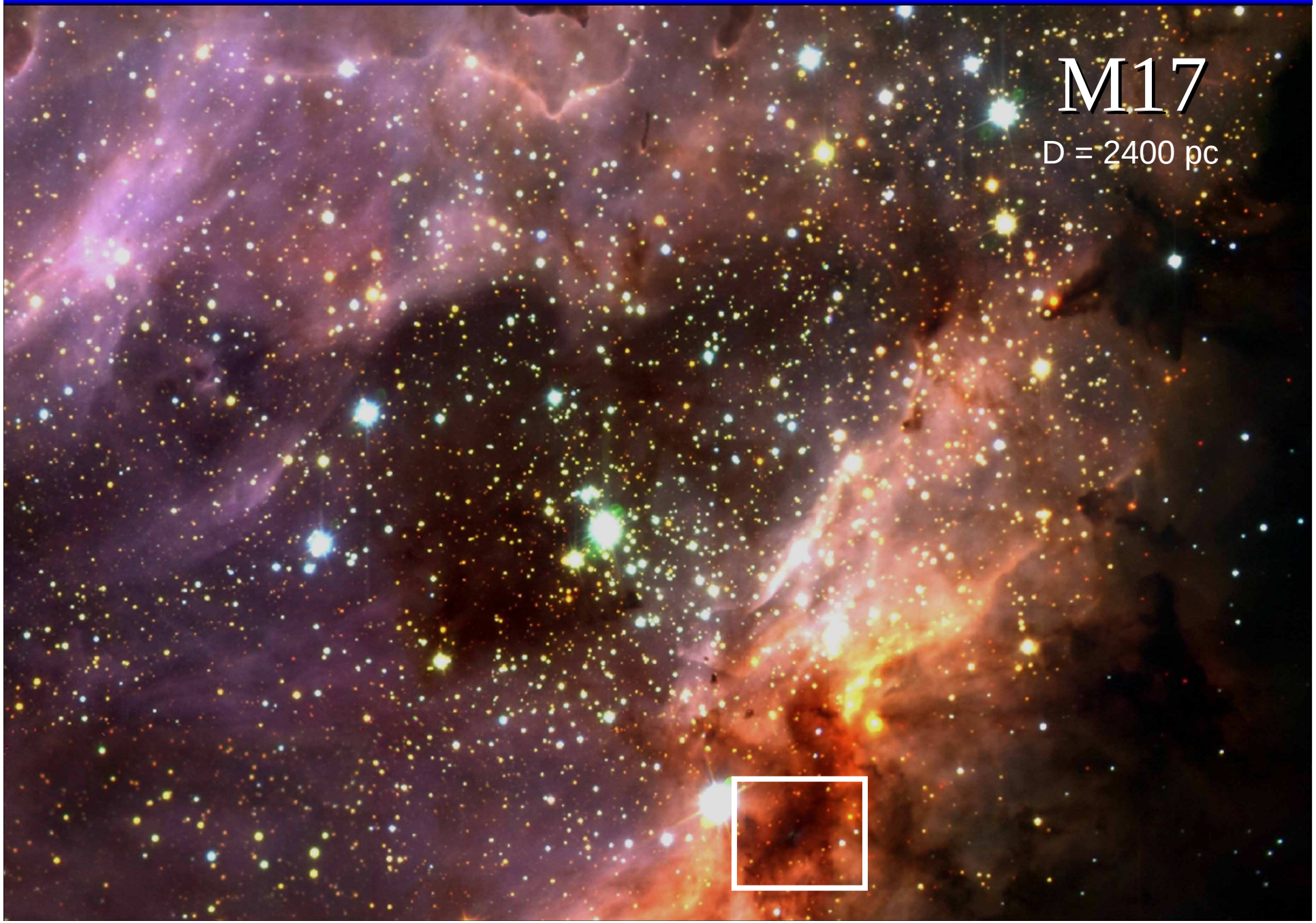


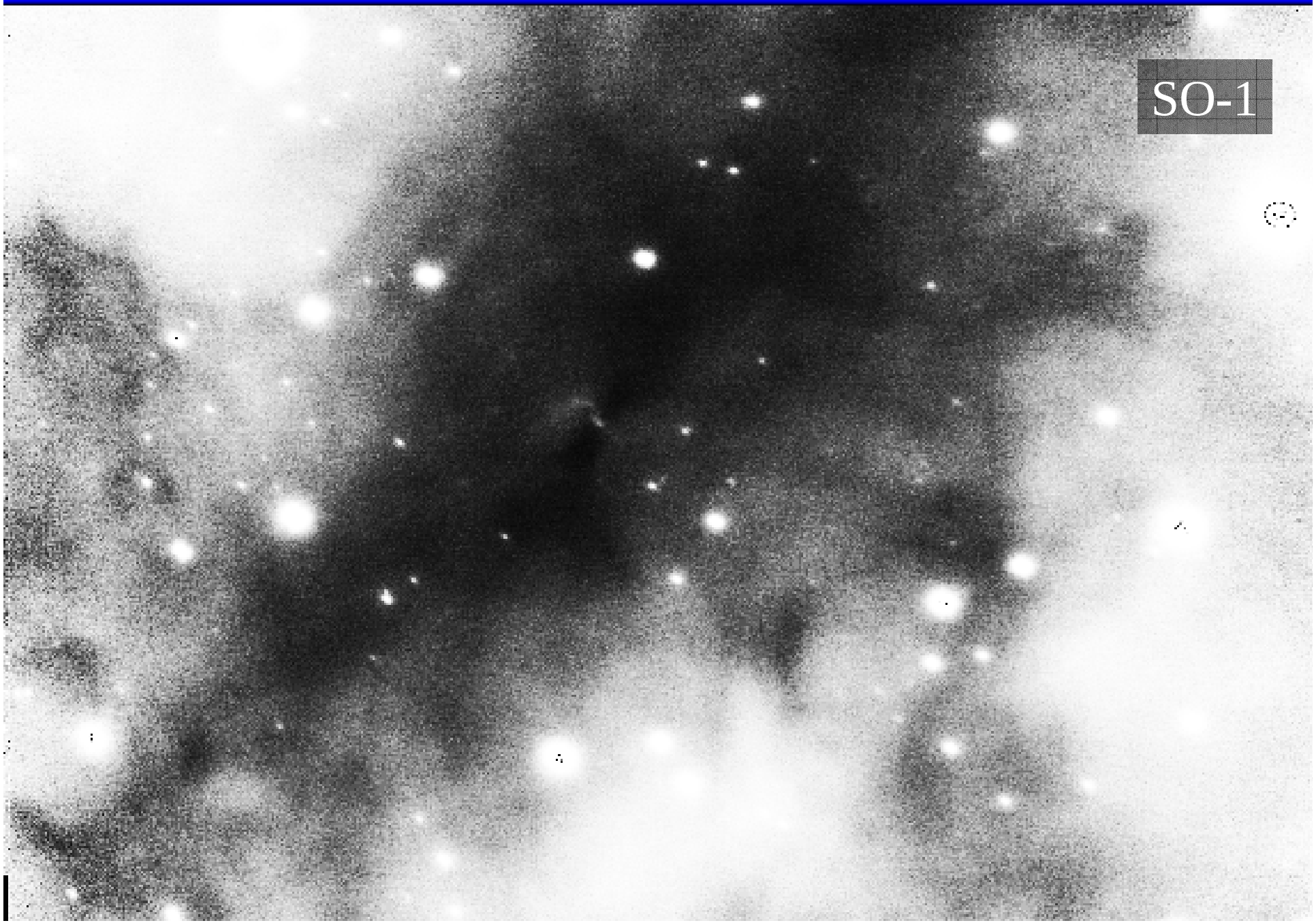
Ray-tracing at high optical depth

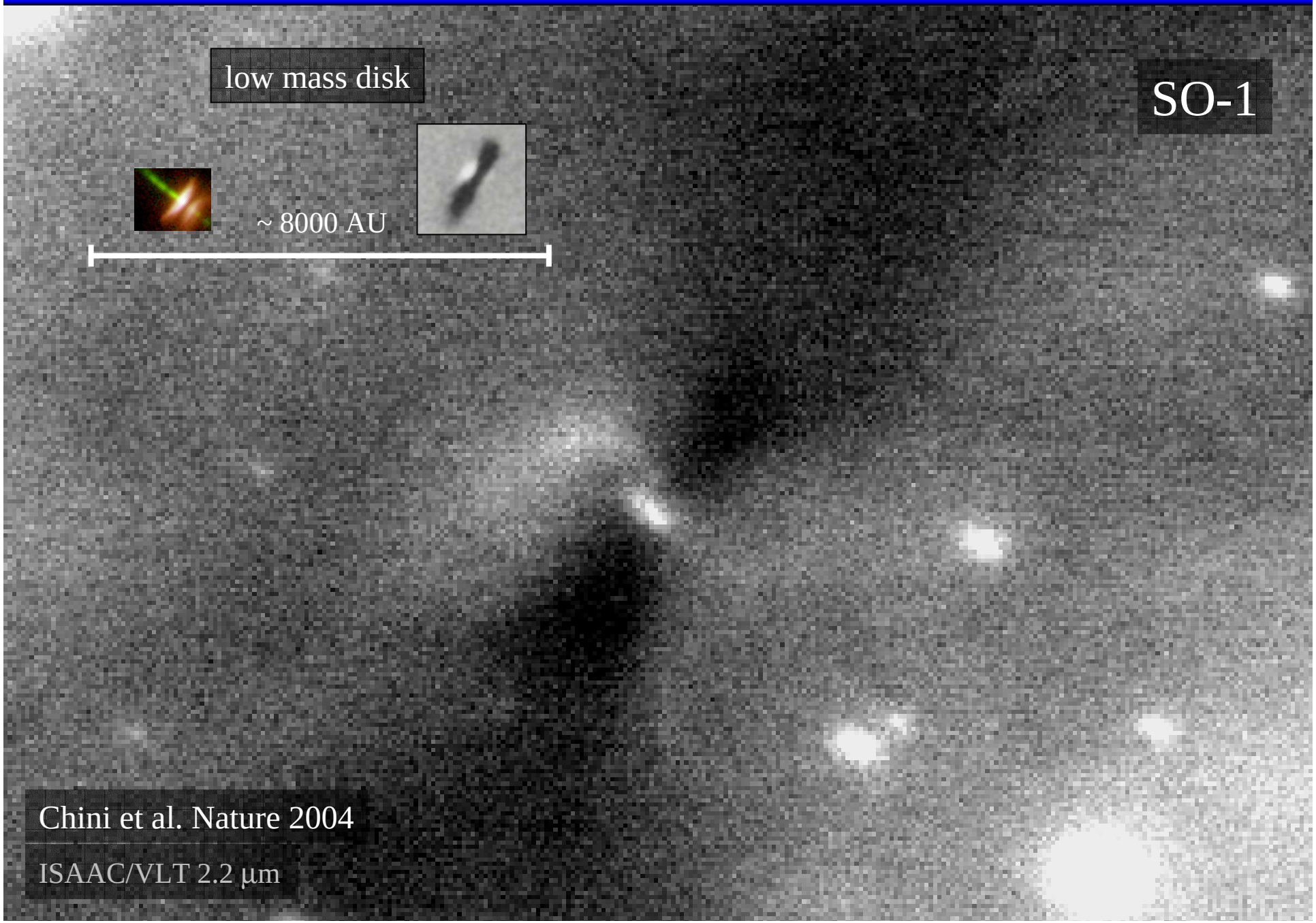
Steinacker, Bacmann, Henning 2006




M17
D = 2400 pc
CFH M17


M17
D = 2400 pc


SO-1

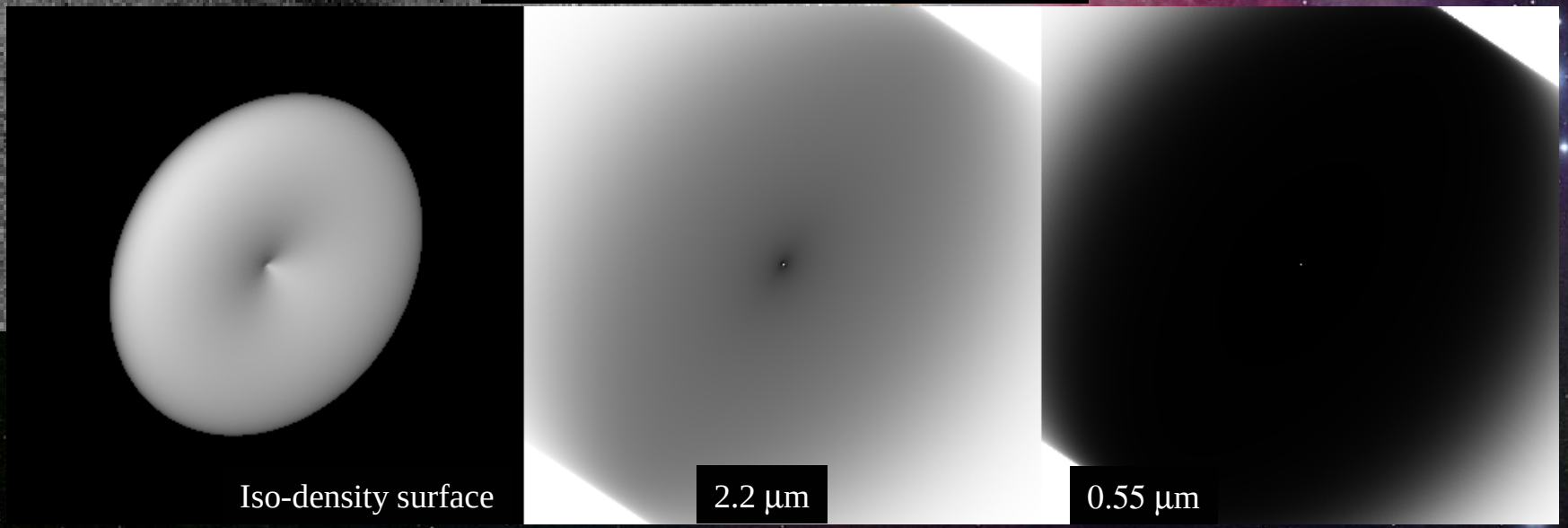

low mass disk
~ 8000 AU
SO-1
Chini et al. Nature 2004
ISAAC/VLT 2.2 μm

SO-1

Steinacker, Chini, Nielbock, Nürnberger, Hoffmeister, Hure, Semenov 2006

Disk mass: 0.2-13 solar masses

8 parameter circumstellar disk fit

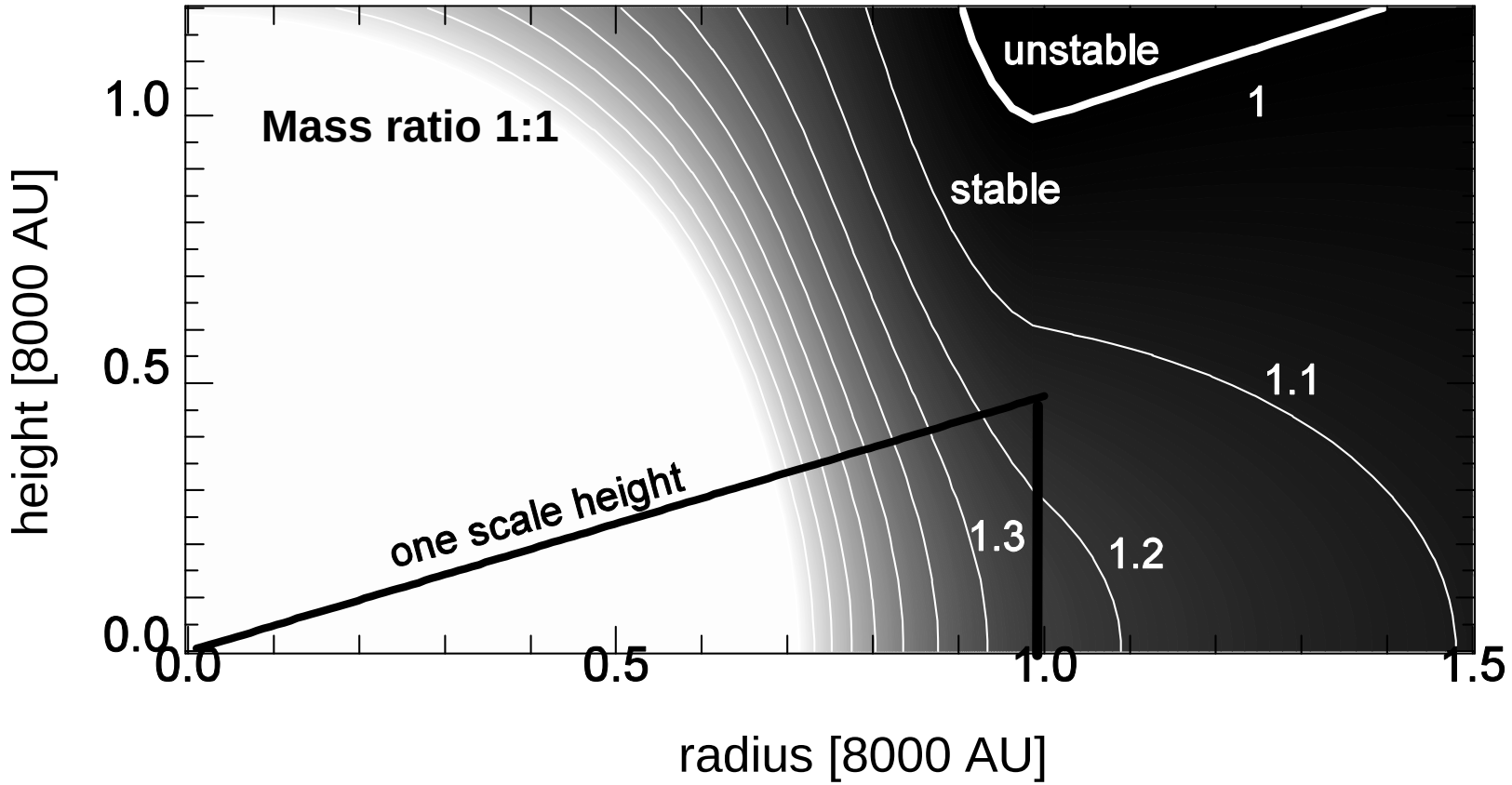


Steinacker, Chini, Nielbock, Nürnberger, Hoffmeister, Hure, Semenov 2006

Given both star and disk are massive:

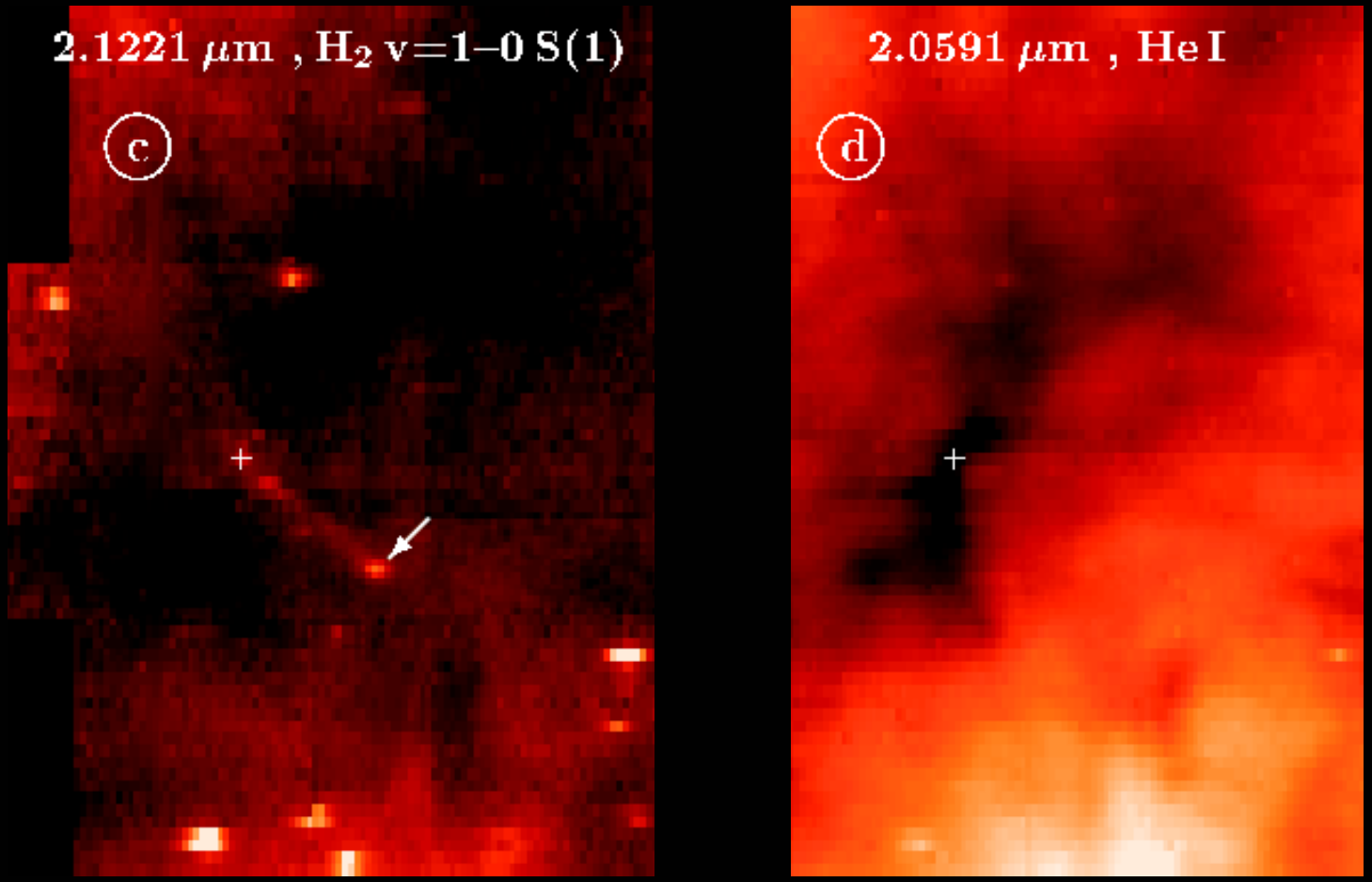
Is such a disk stable?

$$\frac{\text{central gravitational acceleration}}{\text{disk gravitational acceleration}}$$



Collimated jet confirmed

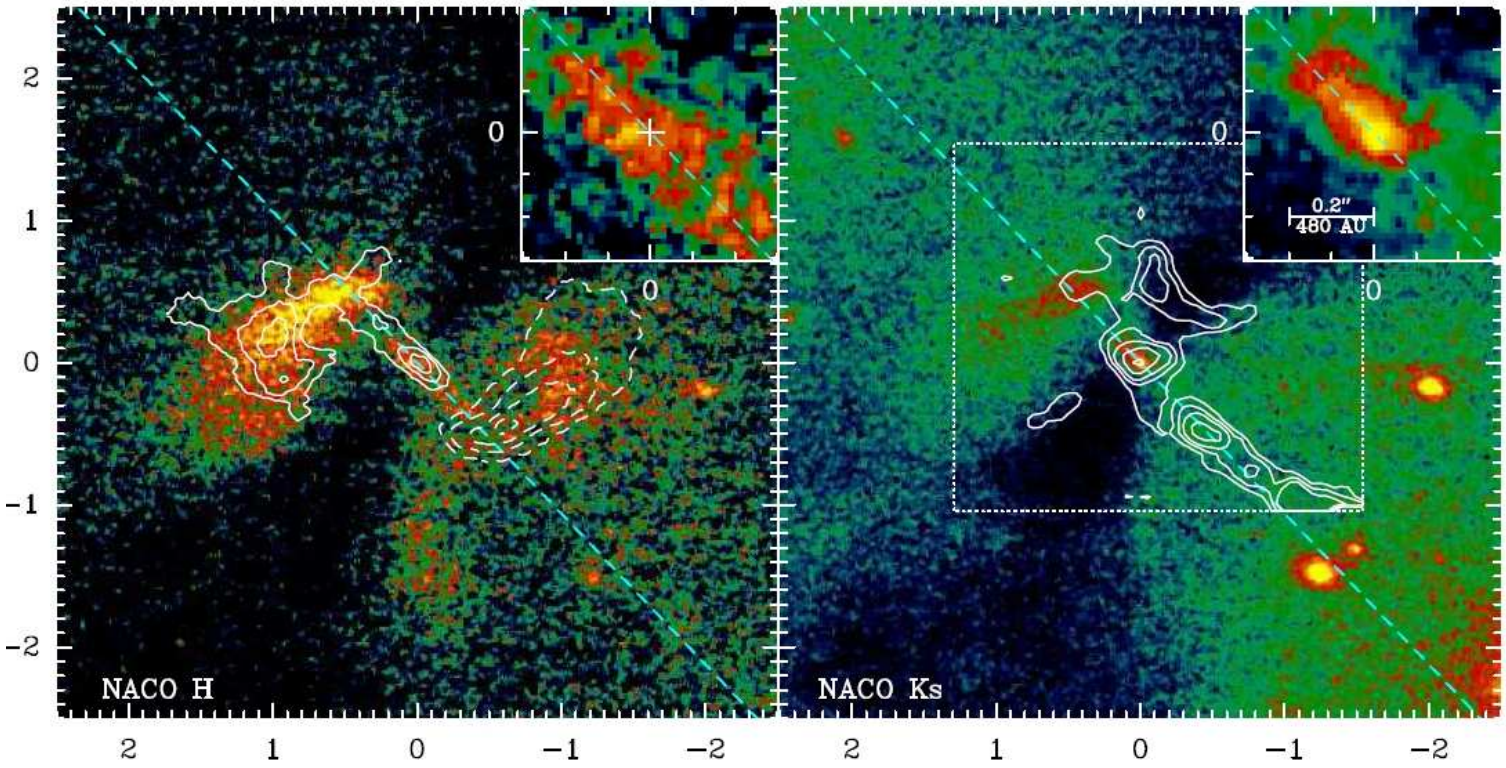
Nürnberger et al. 2007



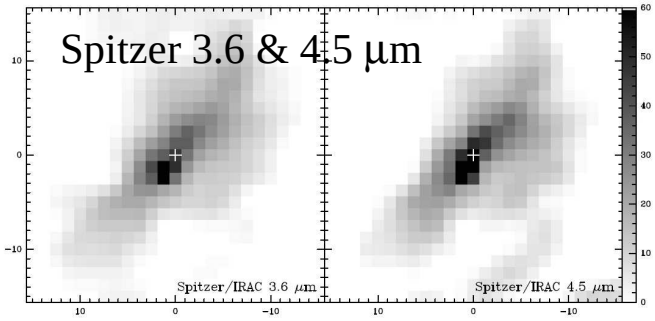
K band integral field spectroscopy SINFONI, VLT

Nielbock, Chini, Hoffmeister, Nürnberger, Scheyda, Steinacker 2007

Central region resolved down to 240 AU

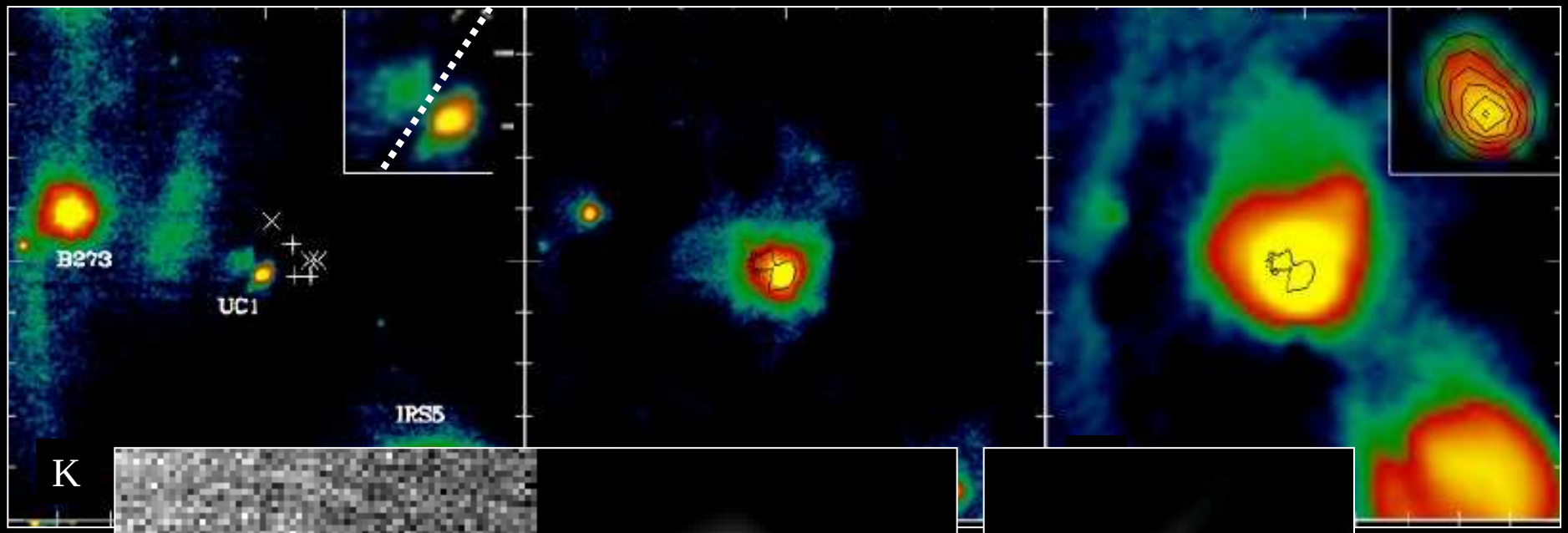


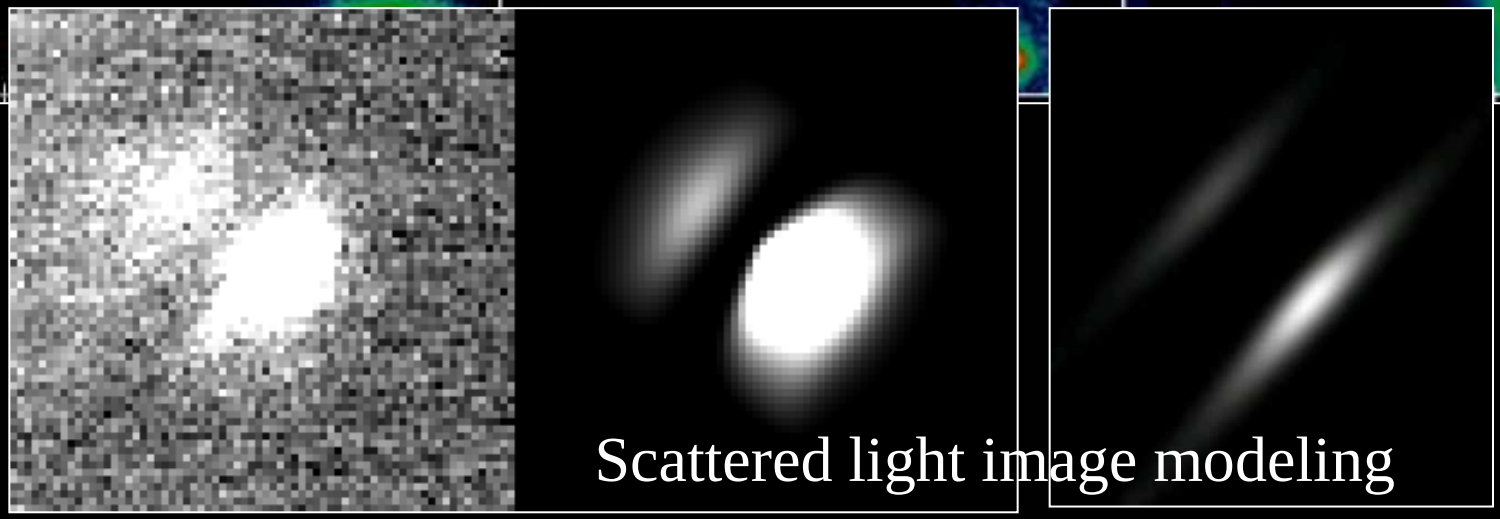
Extinction map from Spitzer as well as H2 emission at the disk surface point towards > B4 star



Nielbock, Chini, Hoffmeister, Scheyda, Steinacker, Nürnberger, Siebenmorgen 2006

UC1 – A *hyper*-compact HII region

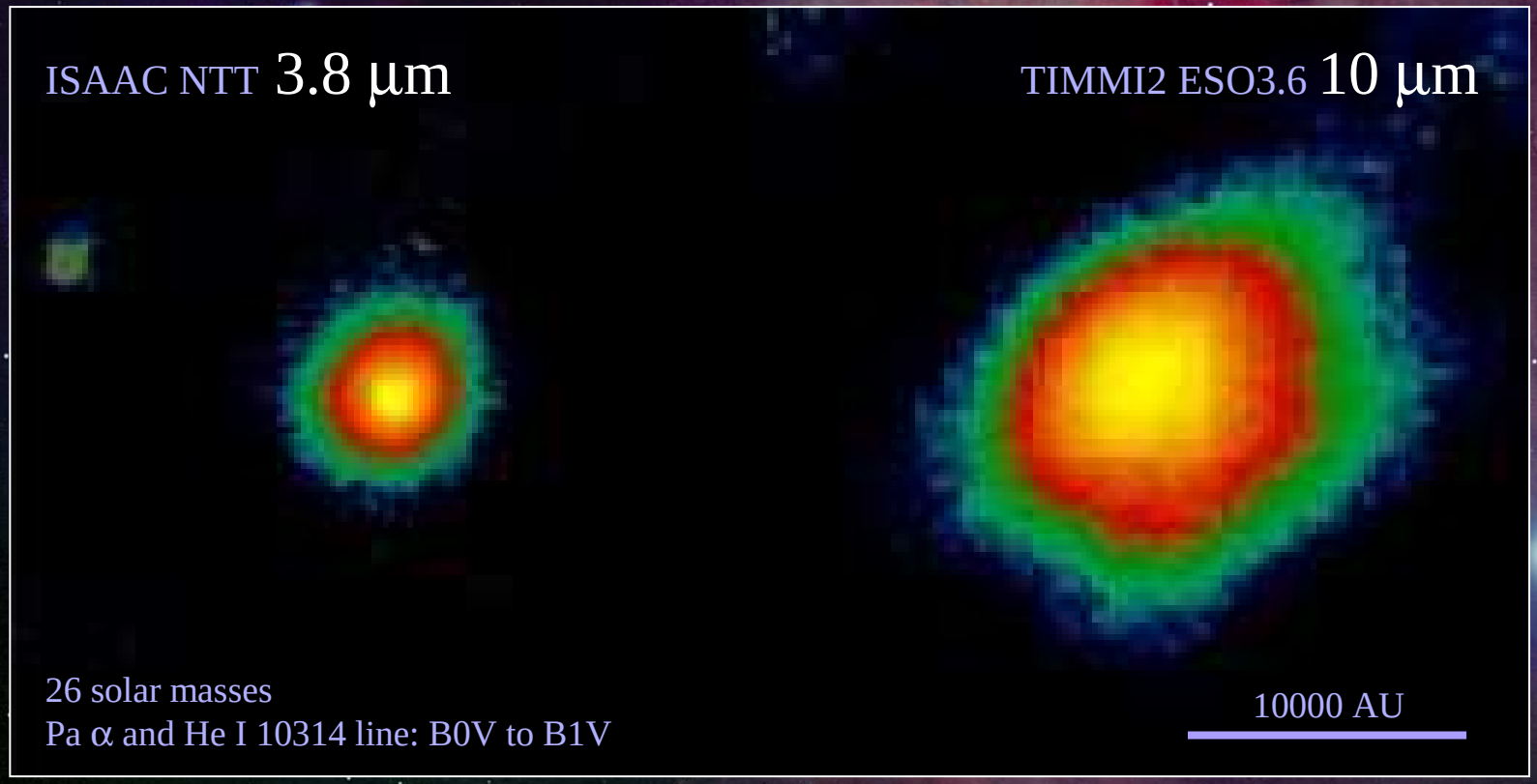




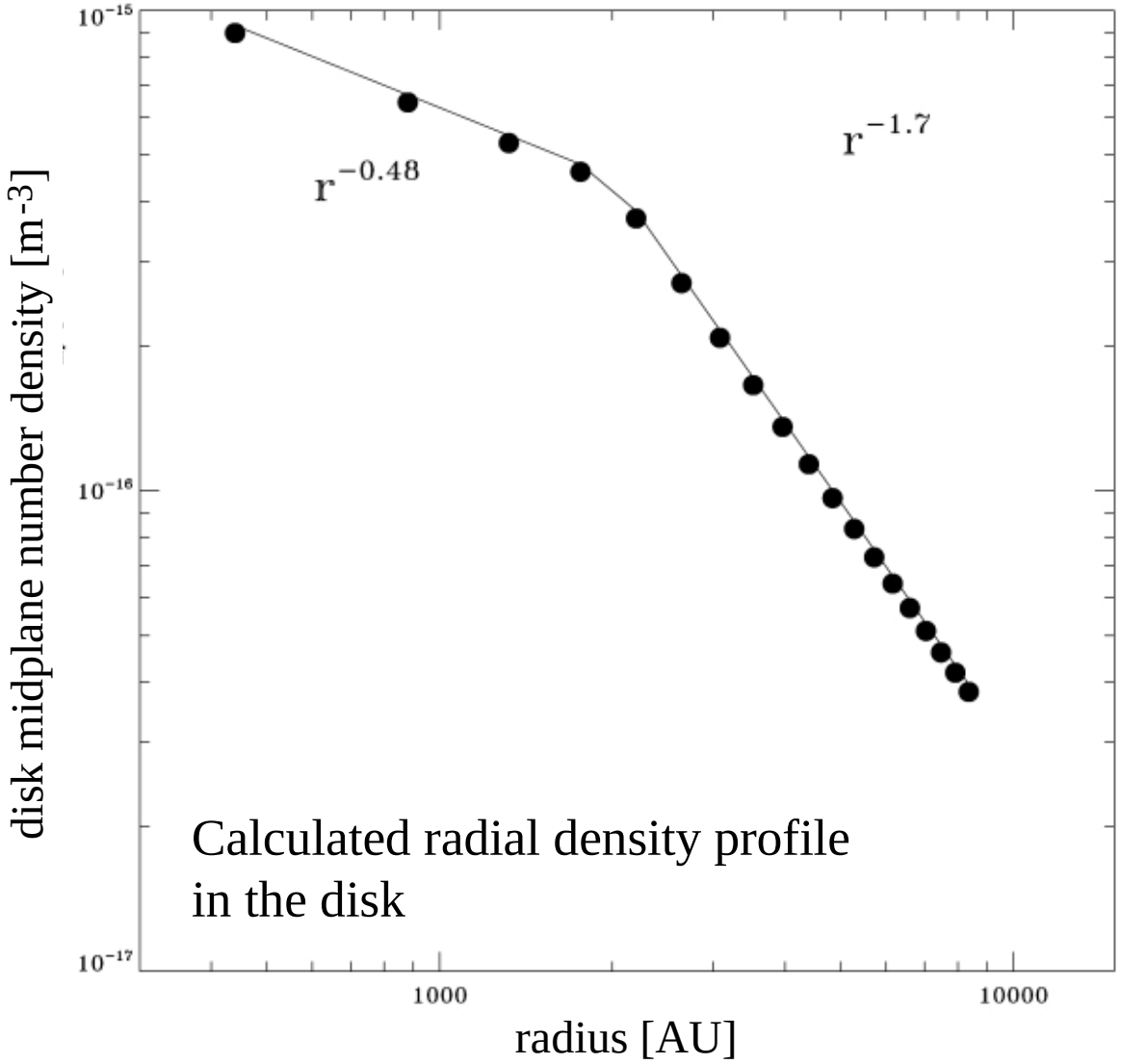
Scattered light image modeling

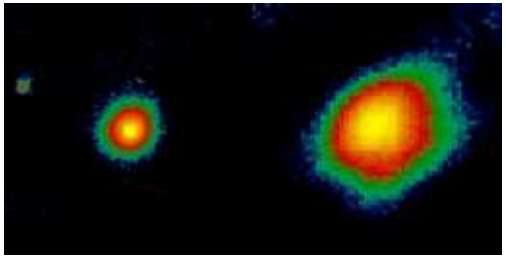
Chini, Hoffmeister, Nielbock, Scheyda, Steinacker, Siebenmorgen, Nürnberger 2006

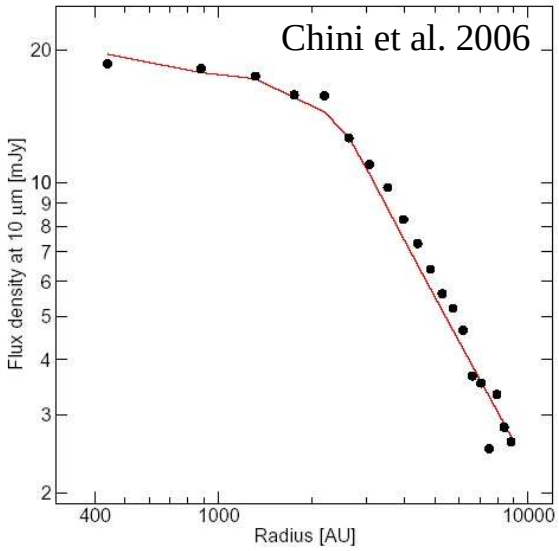
A remnant disk around a massive star (B0)



Indication for an inner cavity



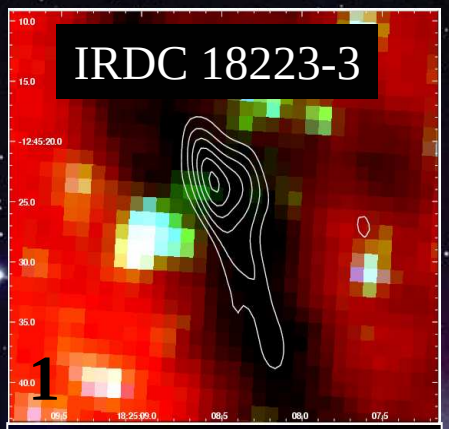


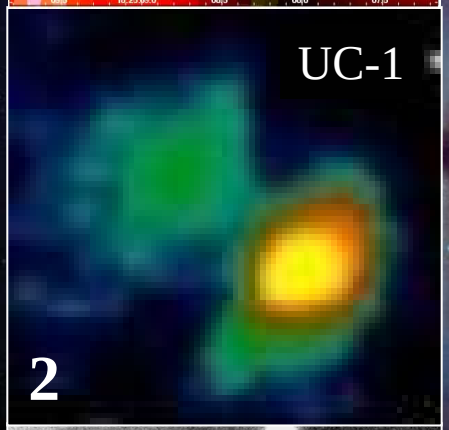


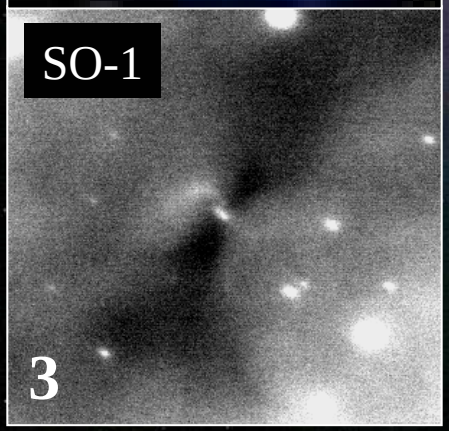
Observed radial flux profile in the disk

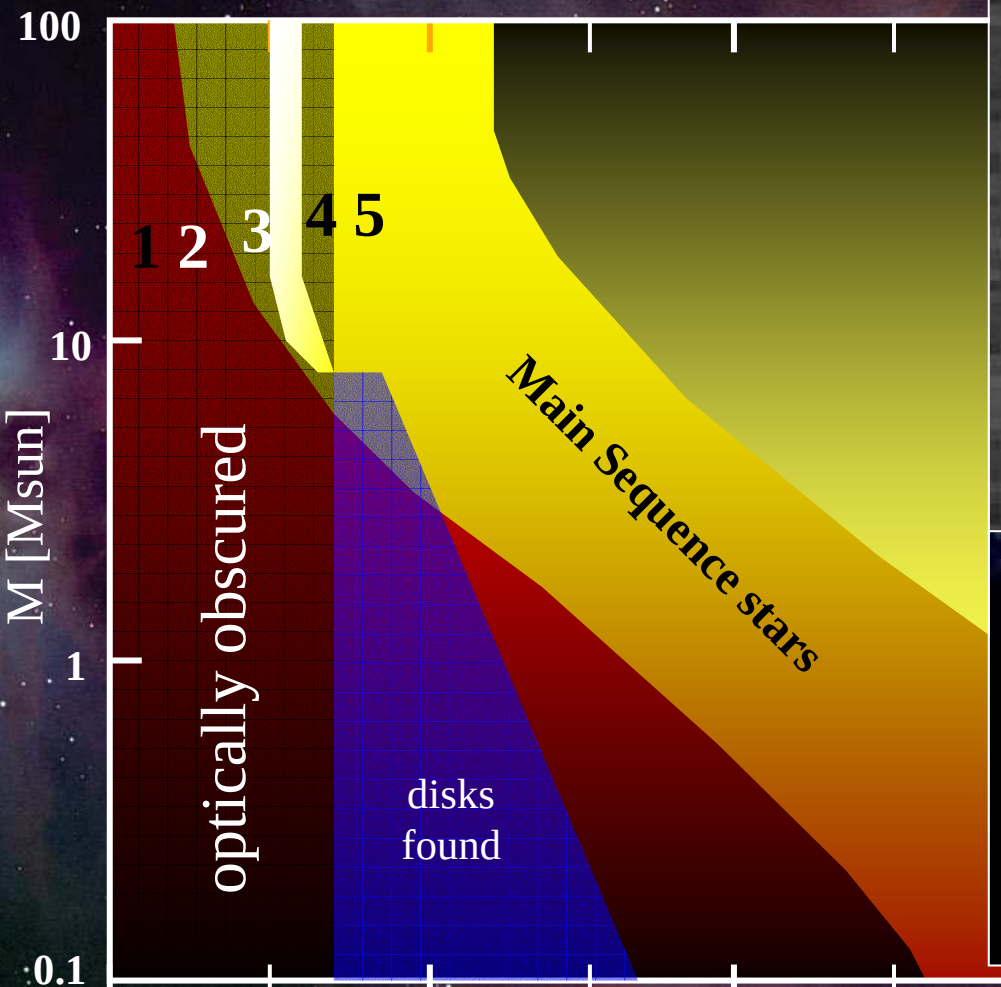
Growing evidence for disk-like structures around Young Massive Stars

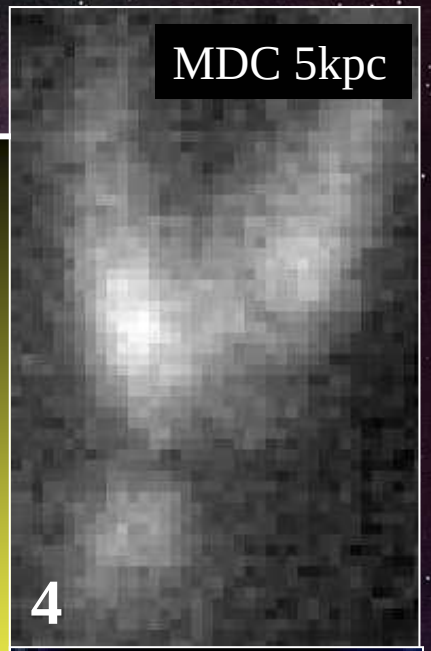
Jürgen Steinacker

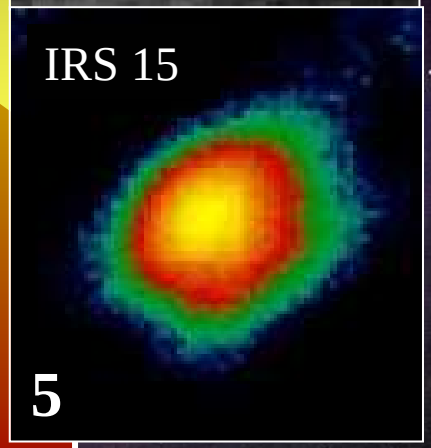


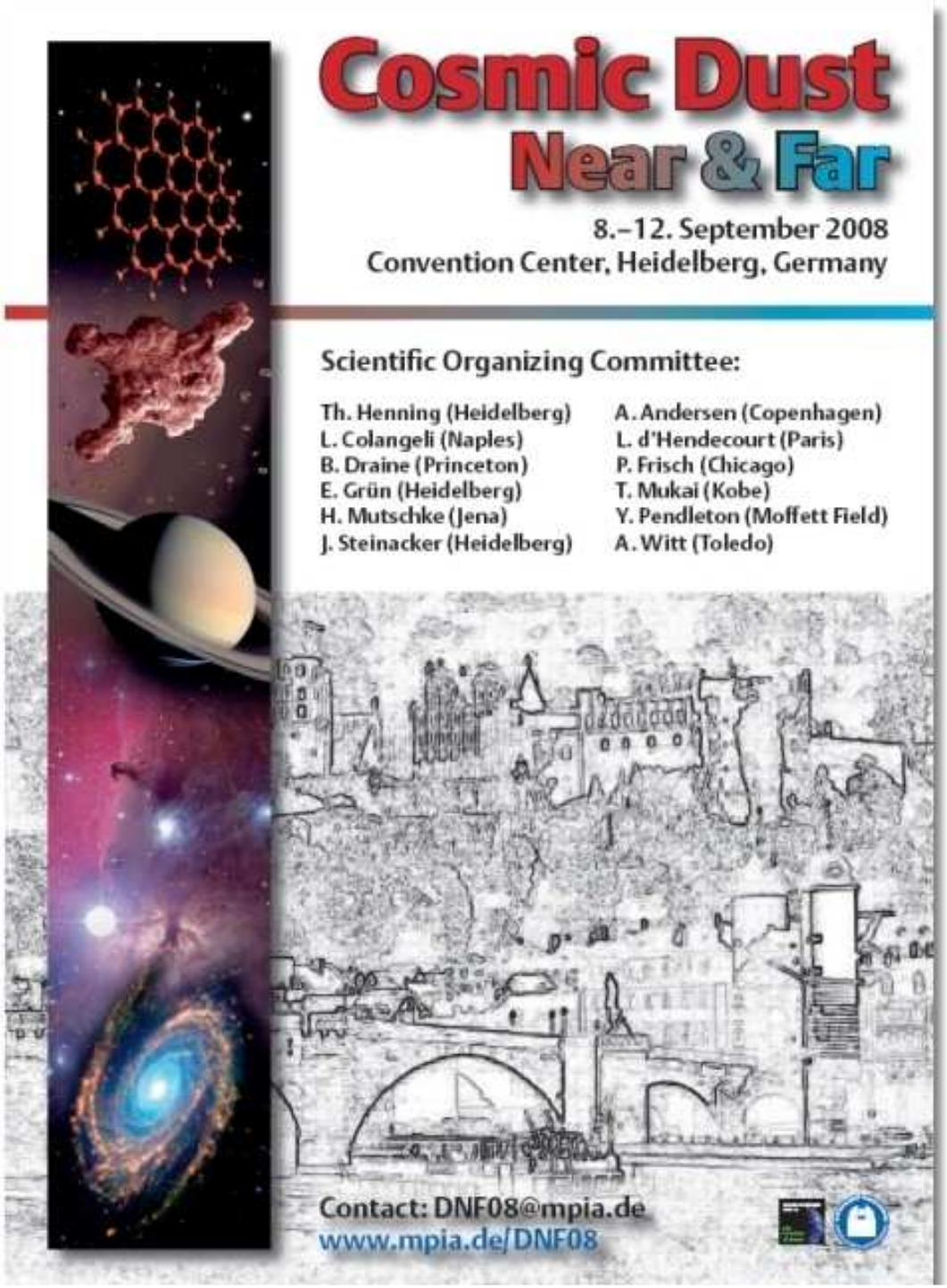












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