FOCUS: The first spatially resolved spectra of the β Pic gas disk

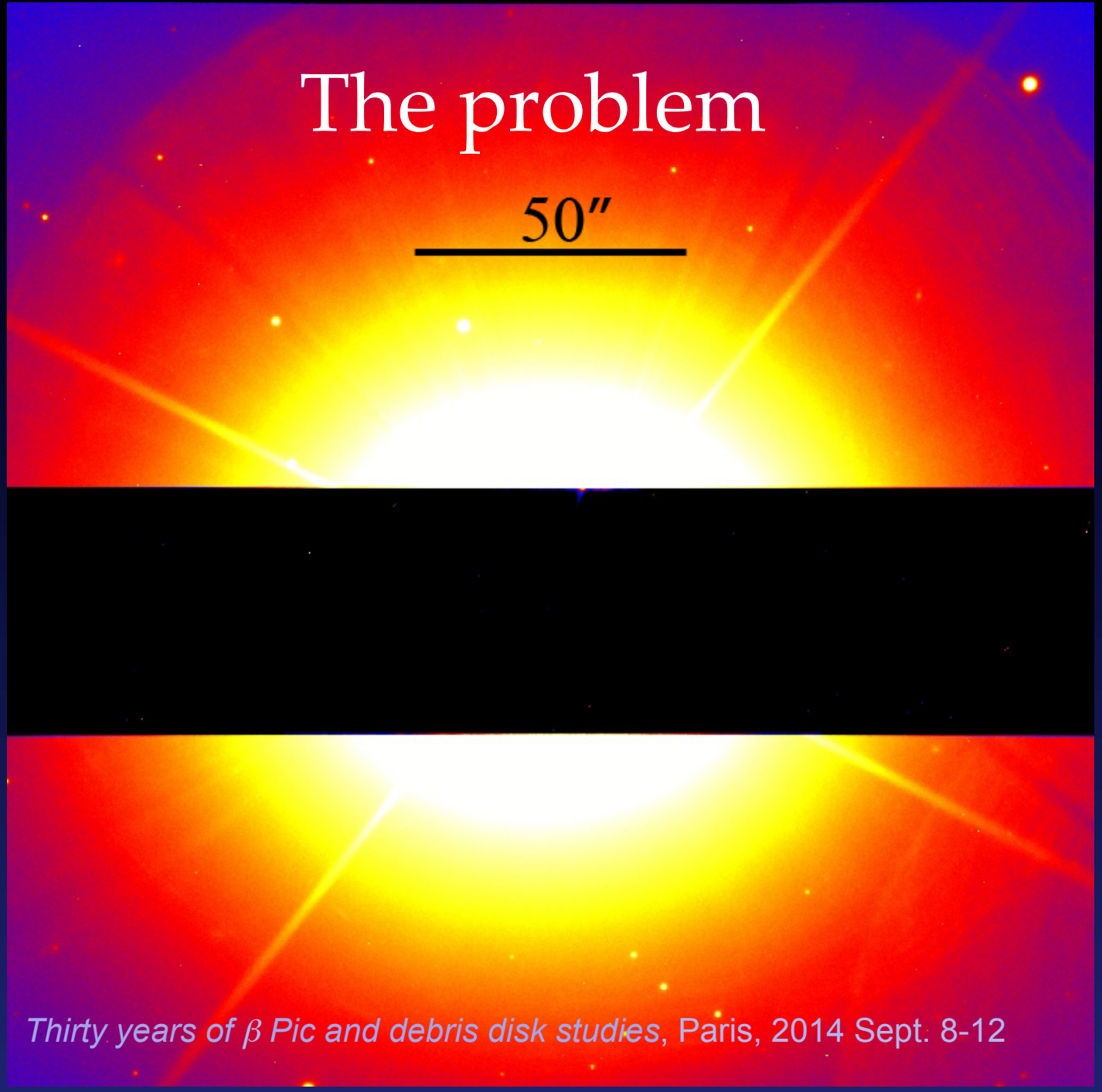
Alexis Brandeker
Stockholm University, Sweden

Thirty years of β Pic and debris disk studies, Paris, 2014 Sept. 8-12

A question from pre-2000

- There is gas around β Pic, but where is it located?
  - In a shell?
  - In the disk?

The problem



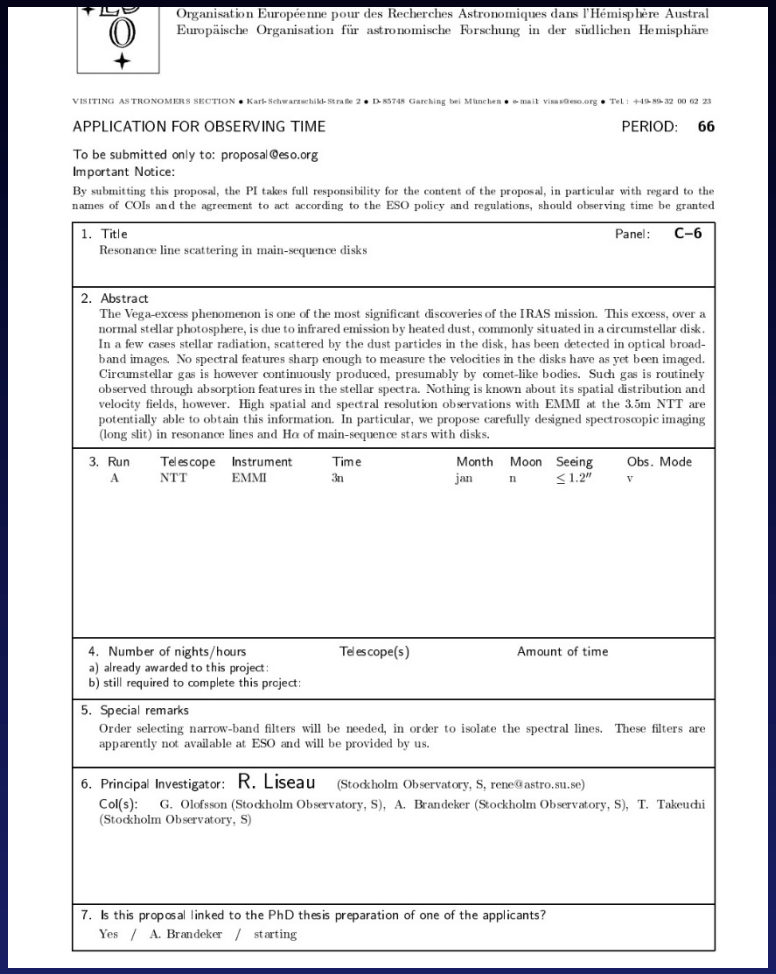
Observational methods

- Heterodyne sub-mm receivers to search for CO, CS, SiO, C I etc?
  - Advantage: very high spectral resolution (R >1e6)
  - Disadvantage: poor angular resolution (> 10″ at the time!)

The Göran Olofsson idea

- Look for emission *scattered* from gas resonance lines
- Optimise sensitivity by simultaneous high spatial and spectral resolution

ESO proposal



Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

VISITING ASTRONOMERS SECTION • Karl-Schwarzschild-Straße 2 • D-85748 Garching bei München • e-mail: visas@eso.org • Tel.: +49-89-32 00 62 23

APPLICATION FOR OBSERVING TIME PERIOD: 66

To be submitted only to: proposal@eso.org
Important Notice:
By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of COIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title Panel: C–6
Resonance line scattering in main-sequence disks

2. Abstract
The Vega-excess phenomenon is one of the most significant discoveries of the IRAS mission. This excess, over a normal stellar photosphere, is due to infrared emission by heated dust, commonly situated in a circumstellar disk. In a few cases stellar radiation, scattered by the dust particles in the disk, has been detected in optical broad-band images. No spectral features sharp enough to measure the velocities in the disks have as yet been imaged. Circumstellar gas is however continuously produced, presumably by comet-like bodies. Such gas is routinely observed through absorption features in the stellar spectra. Nothing is known about its spatial distribution and velocity fields, however. High spatial and spectral resolution observations with EMMI at the 3.5m NTT are potentially able to obtain this information. In particular, we propose carefully designed spectroscopic imaging (long slit) in resonance lines and Hα of main-sequence stars with disks.

3. Run	Telescope	Instrument	Time	Month	Moon	Seeing	Obs. Mode
A	NTT	EMMI	3n	jan	n	$\leq 1.2''$	v

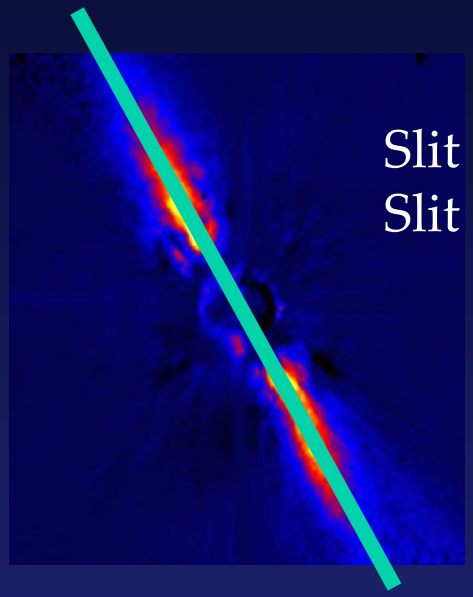
4. Number of nights/hours Telescope(s) Amount of time
a) already awarded to this project:
b) still required to complete this project:

5. Special remarks
Order selecting narrow-band filters will be needed, in order to isolate the spectral lines. These filters are apparently not available at ESO and will be provided by us.

6. Principal Investigator: R. Liseau (Stockholm Observatory, S, rene@astro.su.se)
Col(s): G. Olofsson (Stockholm Observatory, S), A. Brandeker (Stockholm Observatory, S), T. Takeuchi (Stockholm Observatory, S)

7. Is this proposal linked to the PhD thesis preparation of one of the applicants?
Yes / A. Brandeker / starting

- ESO, La Silla, Chile
- 3.5m NTT
- EMMI + long slit (R ≈ 60000)

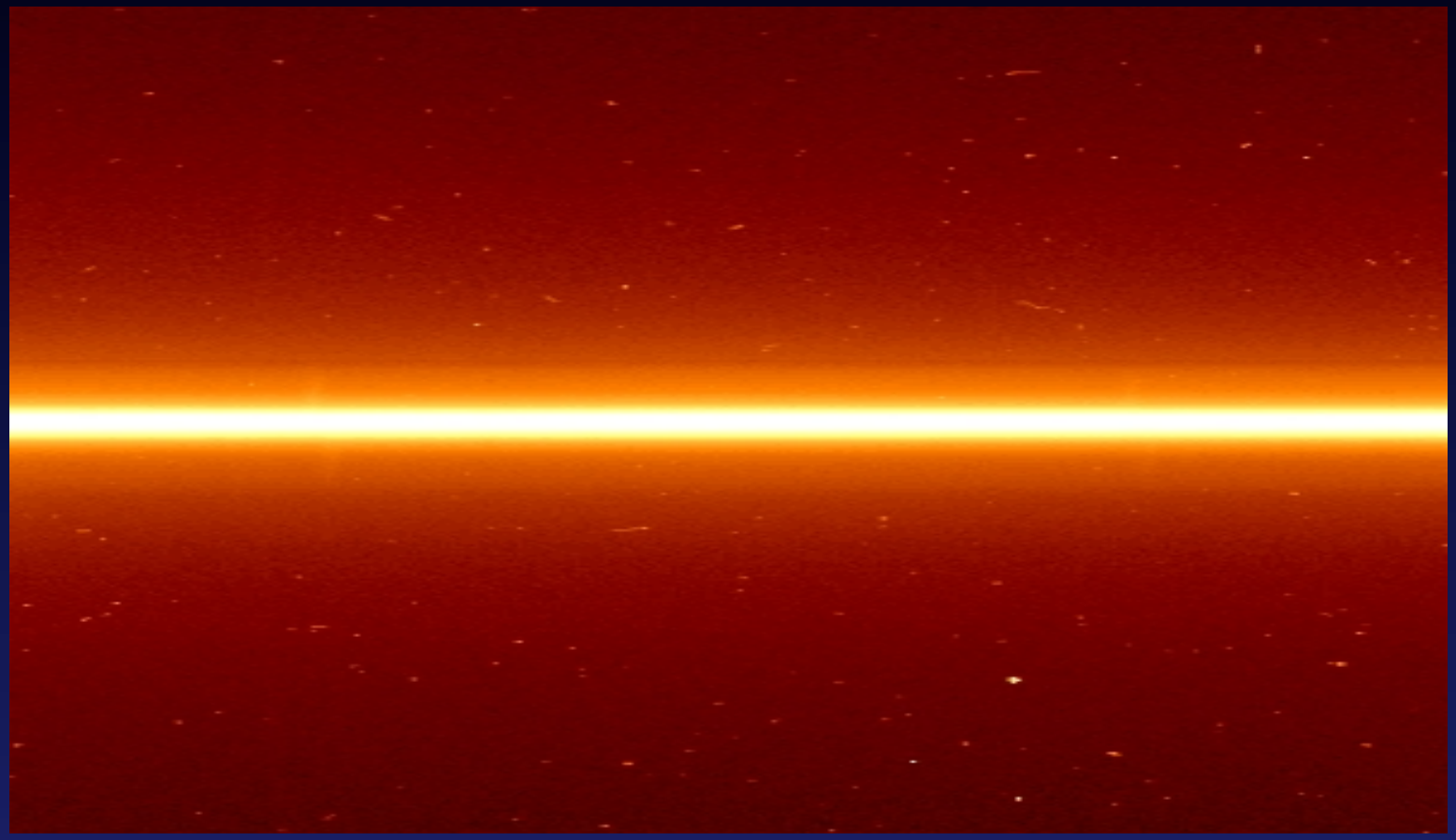


Slit length = 300″
Slit width = 1″

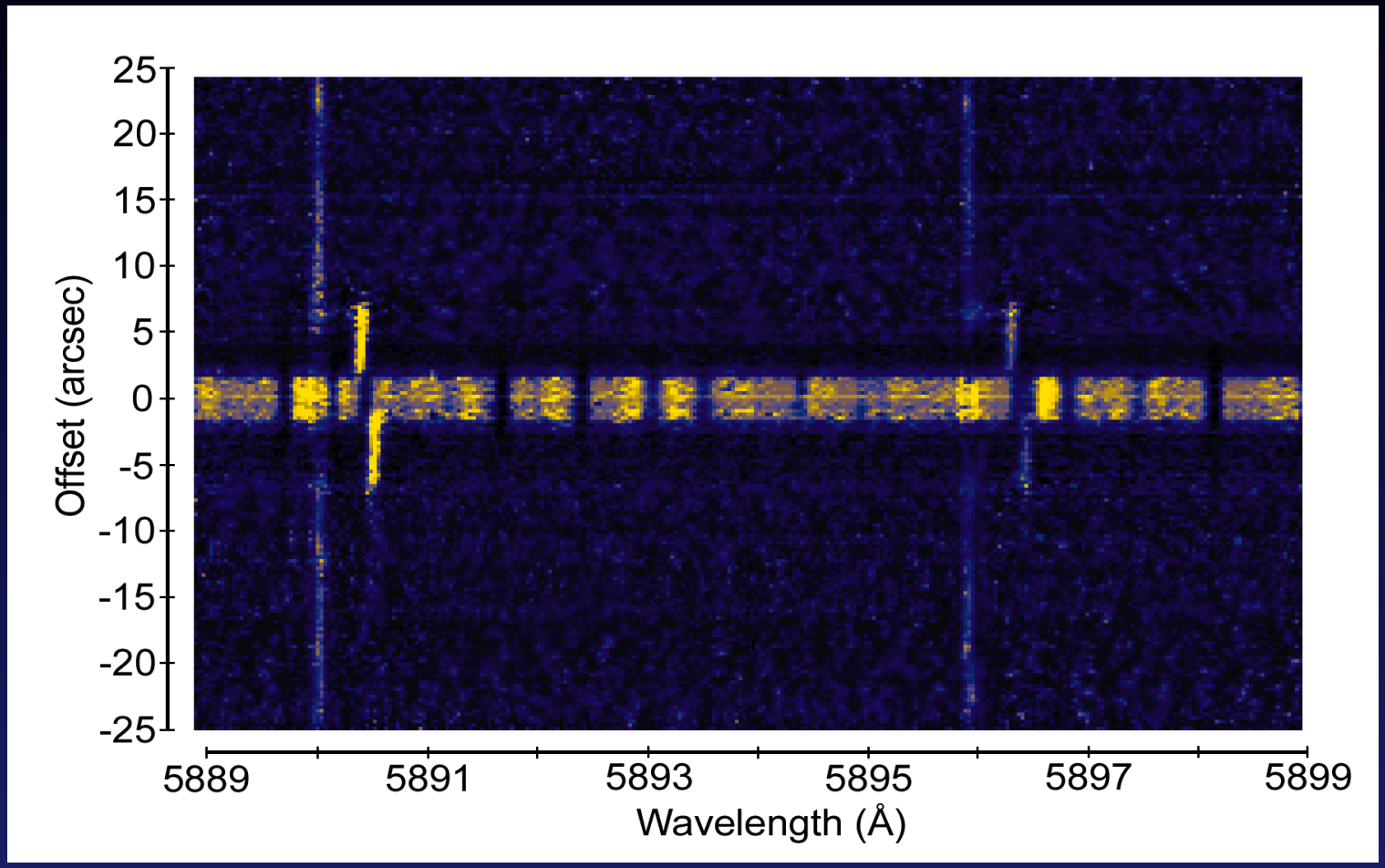
An ancient experiment!

James E. Keeler 1895:
A spectroscopic proof of the meteoric constitution of Saturn's rings, **ApJ 1**, 416-427

Result:



Result:

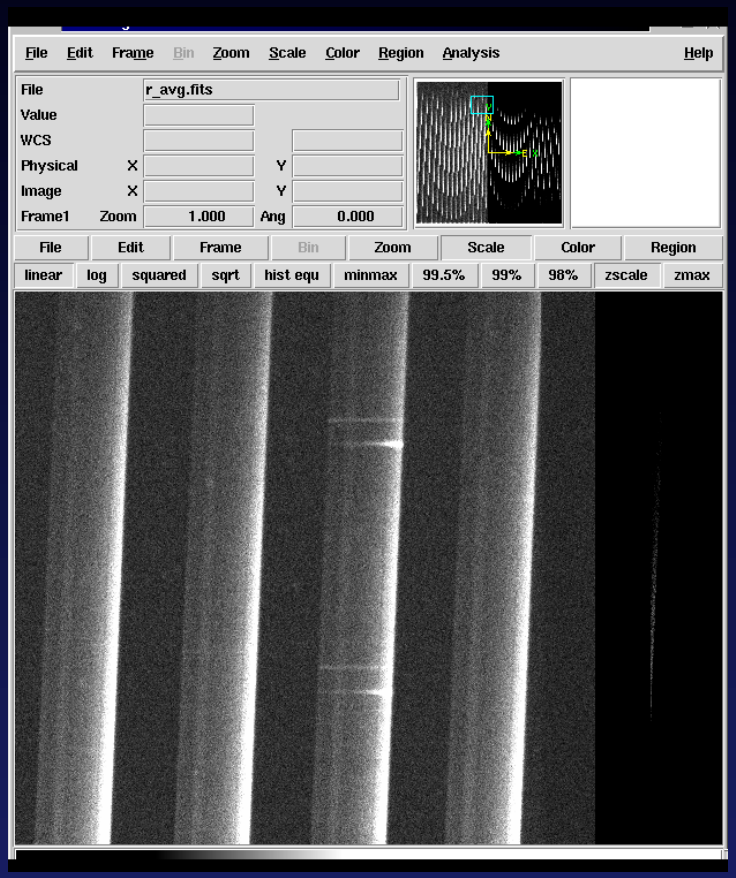


Olofsson, Liseau and Brandeker 2001, ApJL 563

Results & new questions

- Na I is co-located with the dust disk
- Its velocity pattern is consistent with Keplerian motion (with SW coming towards us)
- What is keeping the gas in orbit ($\beta \gg 1$)?
- Where does it originate?

Follow up…



VLT / UVES

- R ~100,000
- seeing < 0.6″