Phase-lag distance of OH 83.4-0.9 from e-MERLIN and NRT Observations

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In collaboration with

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Introduction

- OH/IR stars
  - ➥ ~Miras BUT optically thick circumstellar dust & gas envelopes (CSEs) - periods: 1 year → >5 years - typical diameter 2000 → 10.000 AU (→ 1.25” @ GC / 0.2” @ LMC)

- Distance determination
  - ➥ no optical parallax measurements possible
  - ➥ period-luminosity relation for Miras *(Whitelock et al. 1991)* no longer valid for P> 450 days.
  - ➥ kinematic distances *(from V_rad from OH spectra)* using Galactic rotation curve also impresice *(by up to a factor of 2, Reid et al. 2009)*
  - ➥ VLBI astrometry *(succesfully applied for nearby Miras → D< 2kpc, Vlemmings & van Langevelde 2007)*
  - ➥ Phase-lag distances

Phase-lag method

- OH light curves

  time difference btw blue & red OH maser peak *(long-term monitoring needed)*

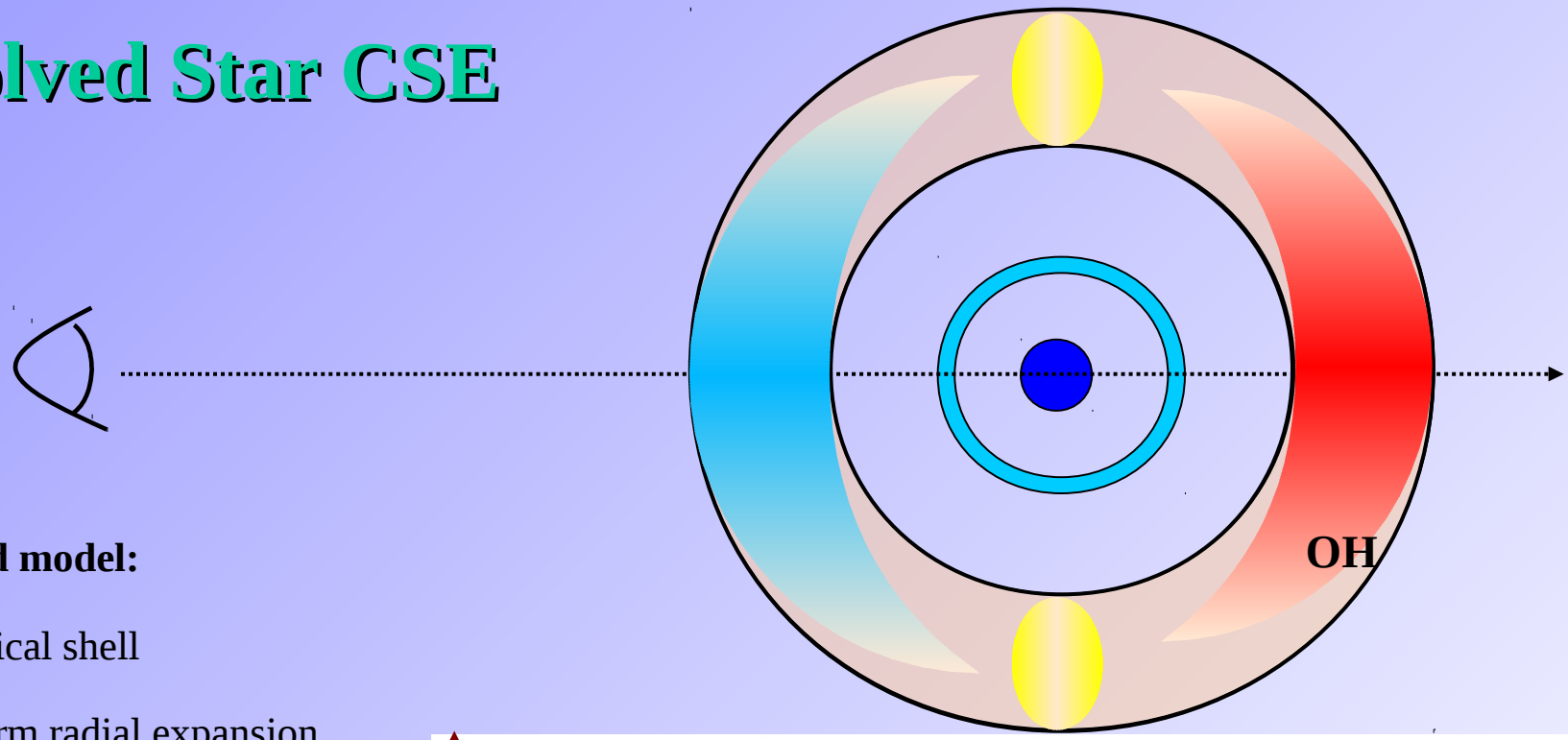
  ➥ linear diameter

- Interferometric maps

  measure of the OH shell extent

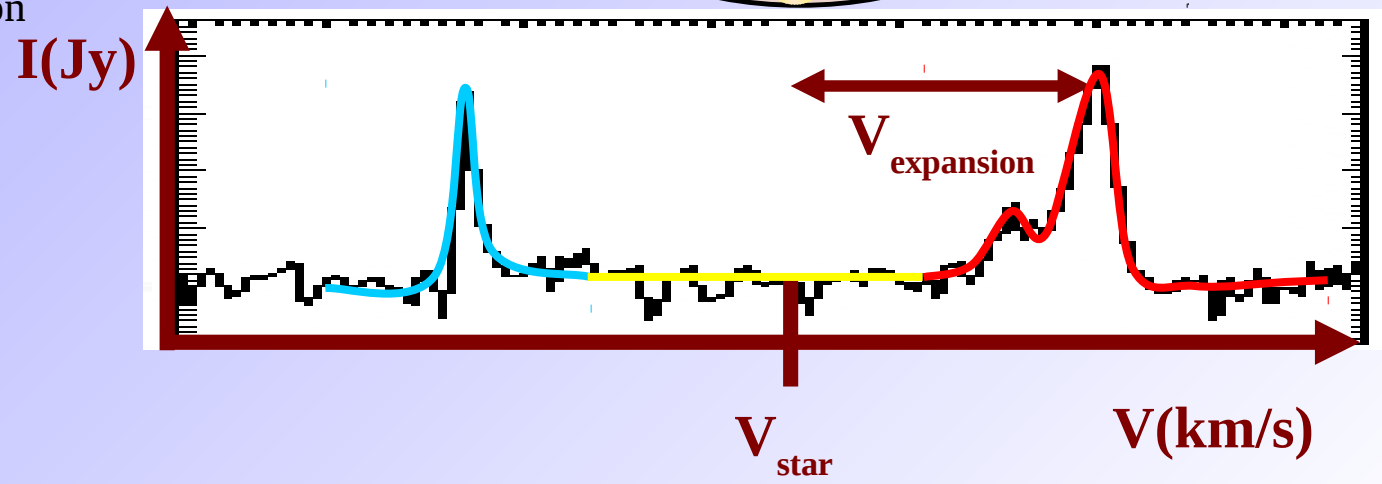
  ➥ angular diameter

Evolved Star CSE

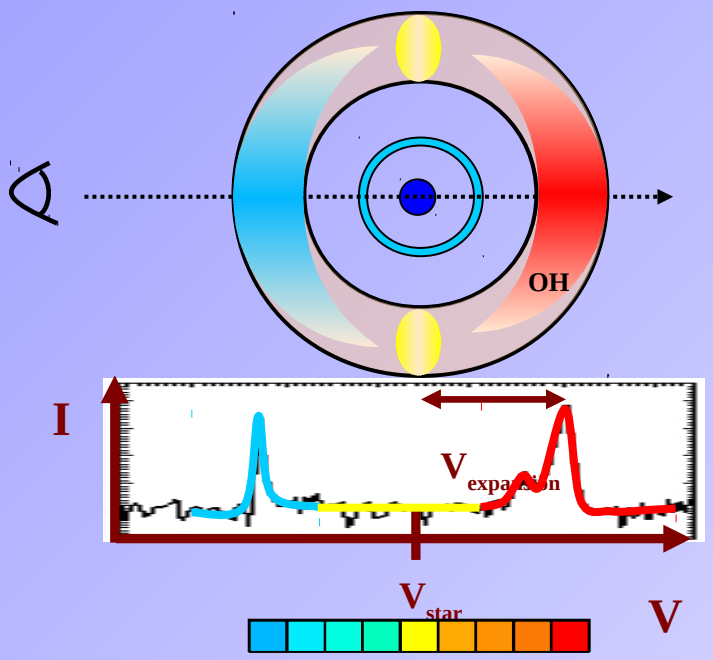


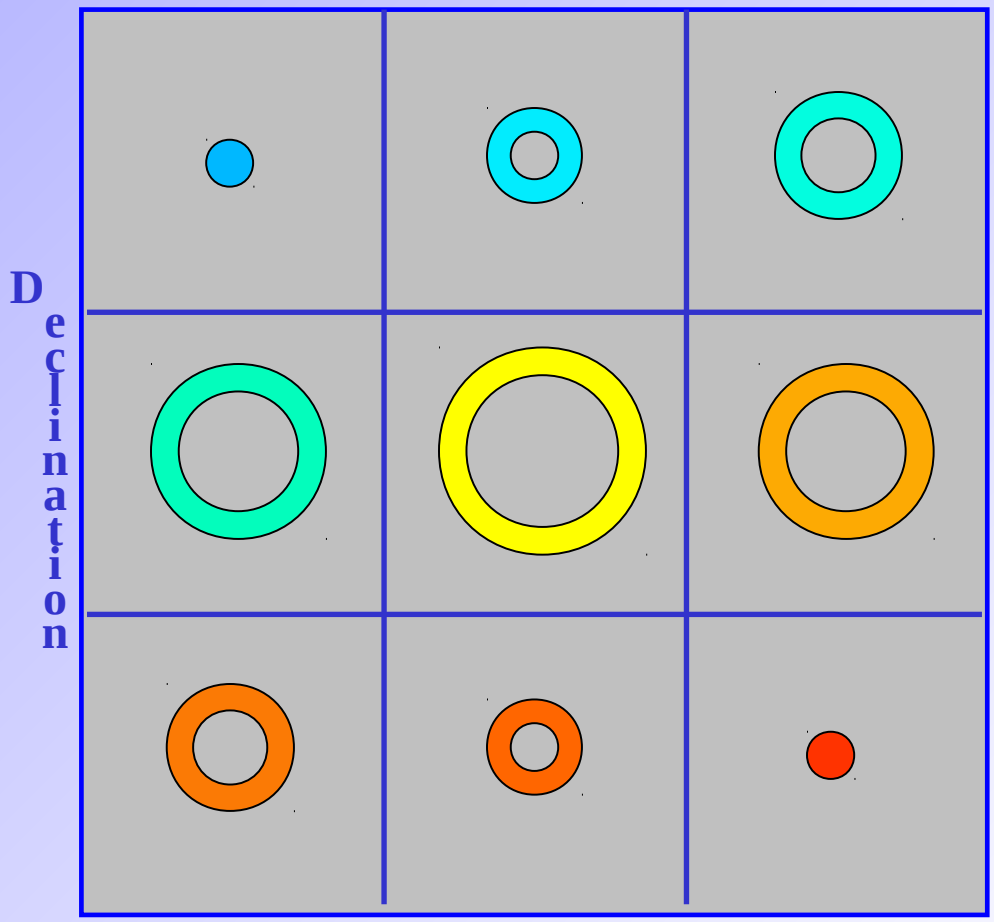
Standard model:

- Spherical shell
- Uniform radial expansion

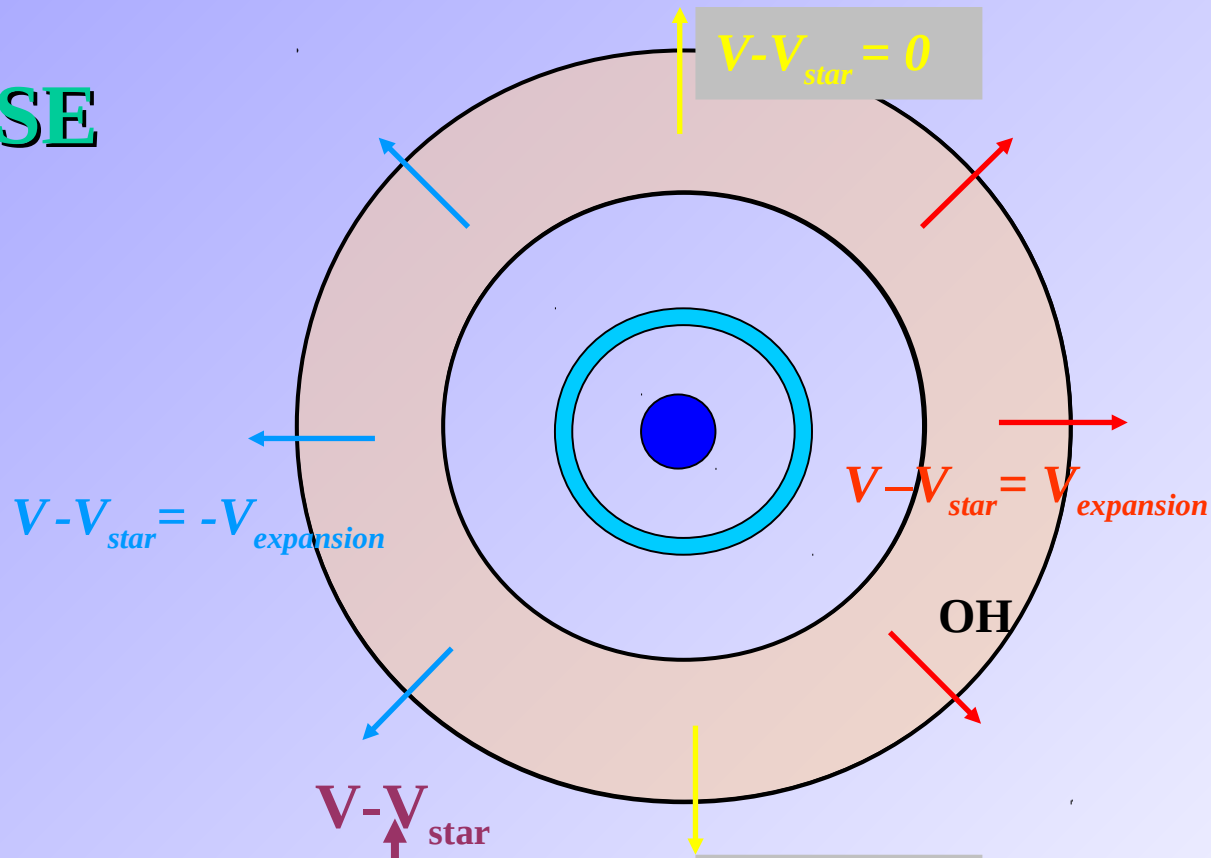


Evolved Star CSE





Evolved Star CSE



Standard model:

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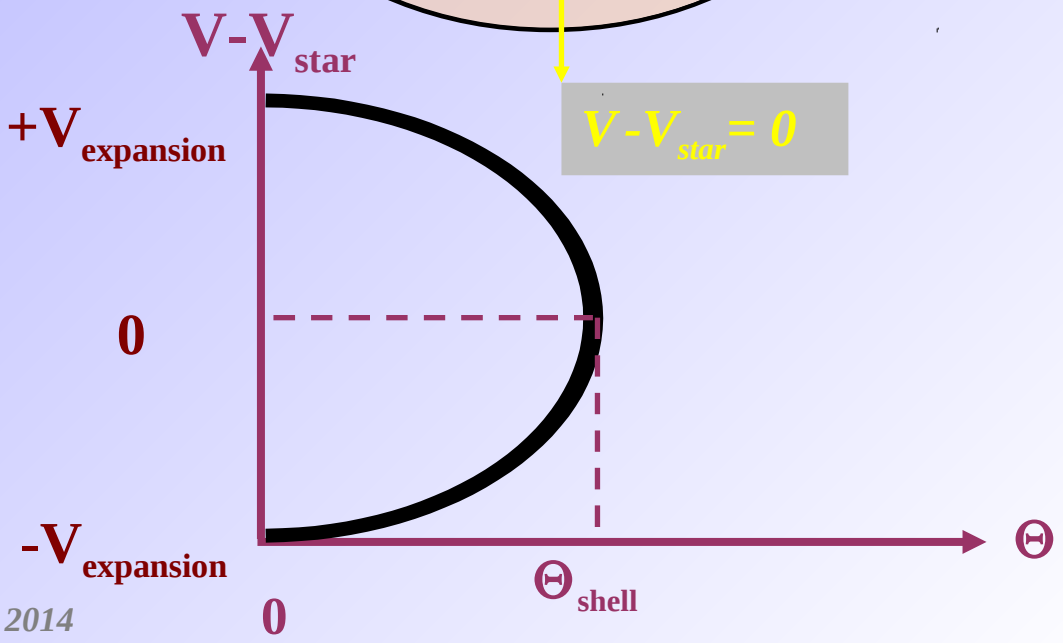
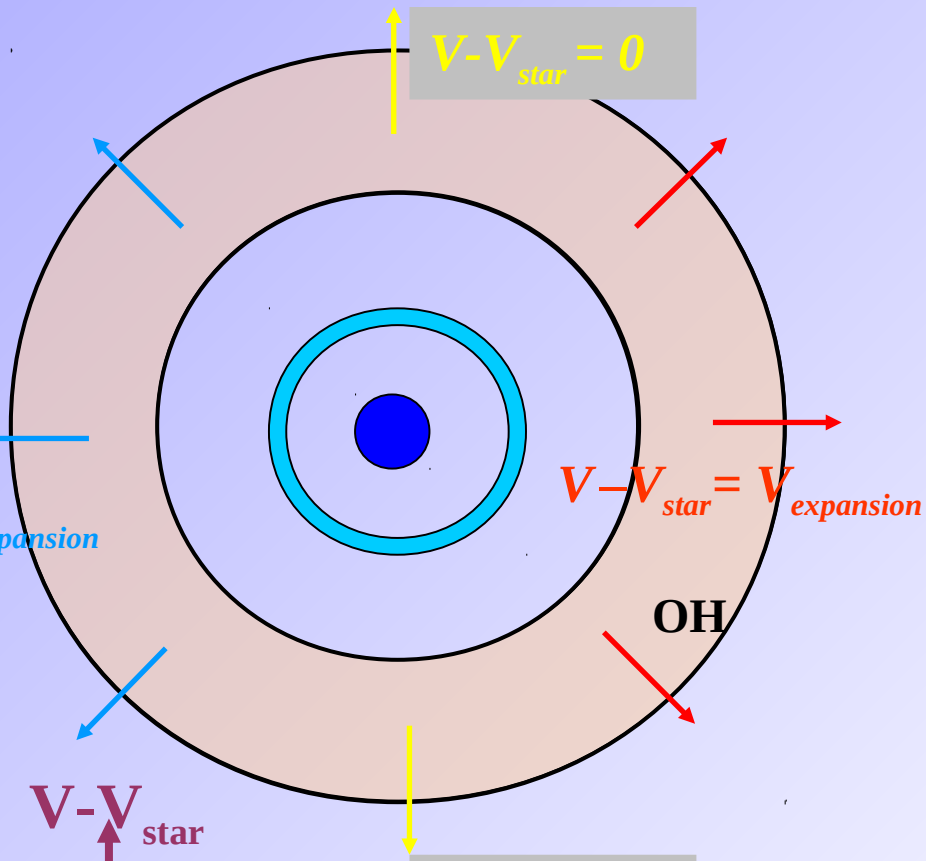
Velocity distribution:

$$\left[\frac{\Theta}{\Theta_{shell}}\right]^2 + \left[\frac{V - V_{star}}{V_{expansion}}\right]^2 = 1$$

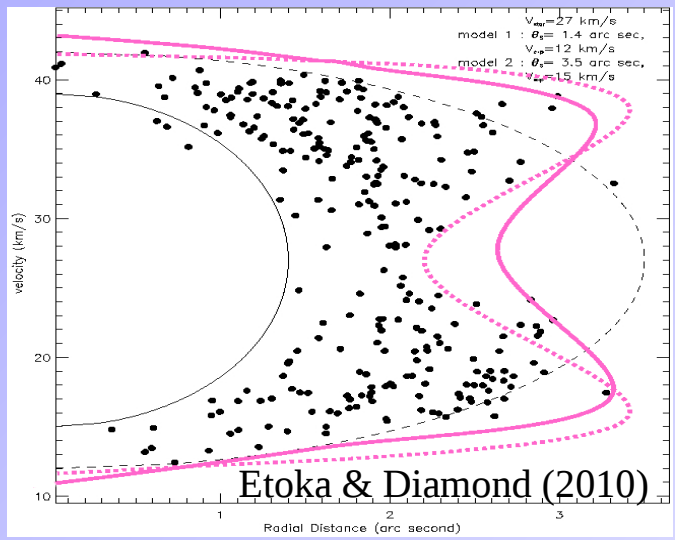


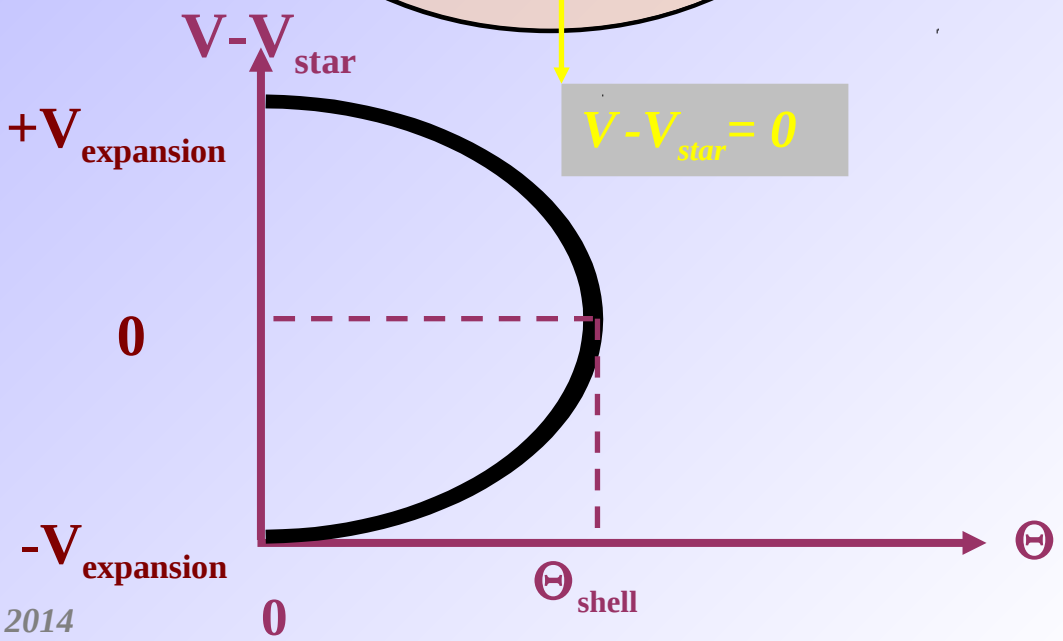
Evolved Star CSE



Caveat: deviation from the thin-spherical-shell model

- Distance uncertainty > 20%





Phase-lag method

- OH light curves

  time difference btw blue & red OH maser peak (long-term monitoring needed)

  ➥ linear diameter

- Interferometric maps

  measure of the OH shell extent

  ➥ angular diameter

- Method

  ➥ Proof of concept: Schultz, Sherwood & Winnberg (1978)

  2 years monitoring towards 12 OH/IR stars

  ➥ Systematic exploration:

  Herman & Habing (1985, *29 diameters determined*)

  van Langevelde et al. (1990, *15 sources in common btw the 2 but 5 diameters only matching within 50%)*

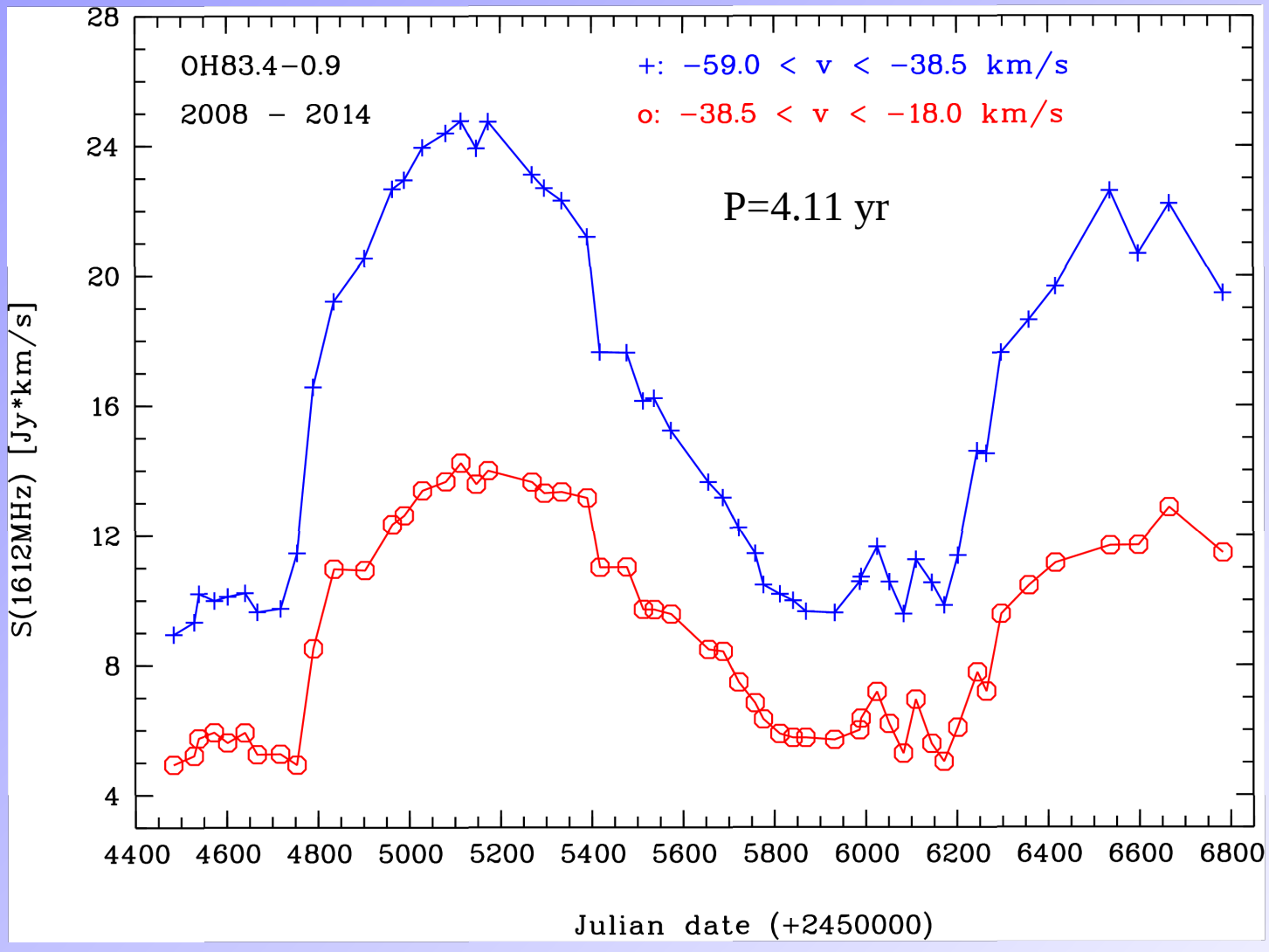
Observations

- OH light curves *(linear diameter)*
  - ➥ NRT long-term monitoring of 20 sources (*monthly*, 6 years now)
    Sensitivity: 100 mJy – velocity resolution : 0.035 km/s

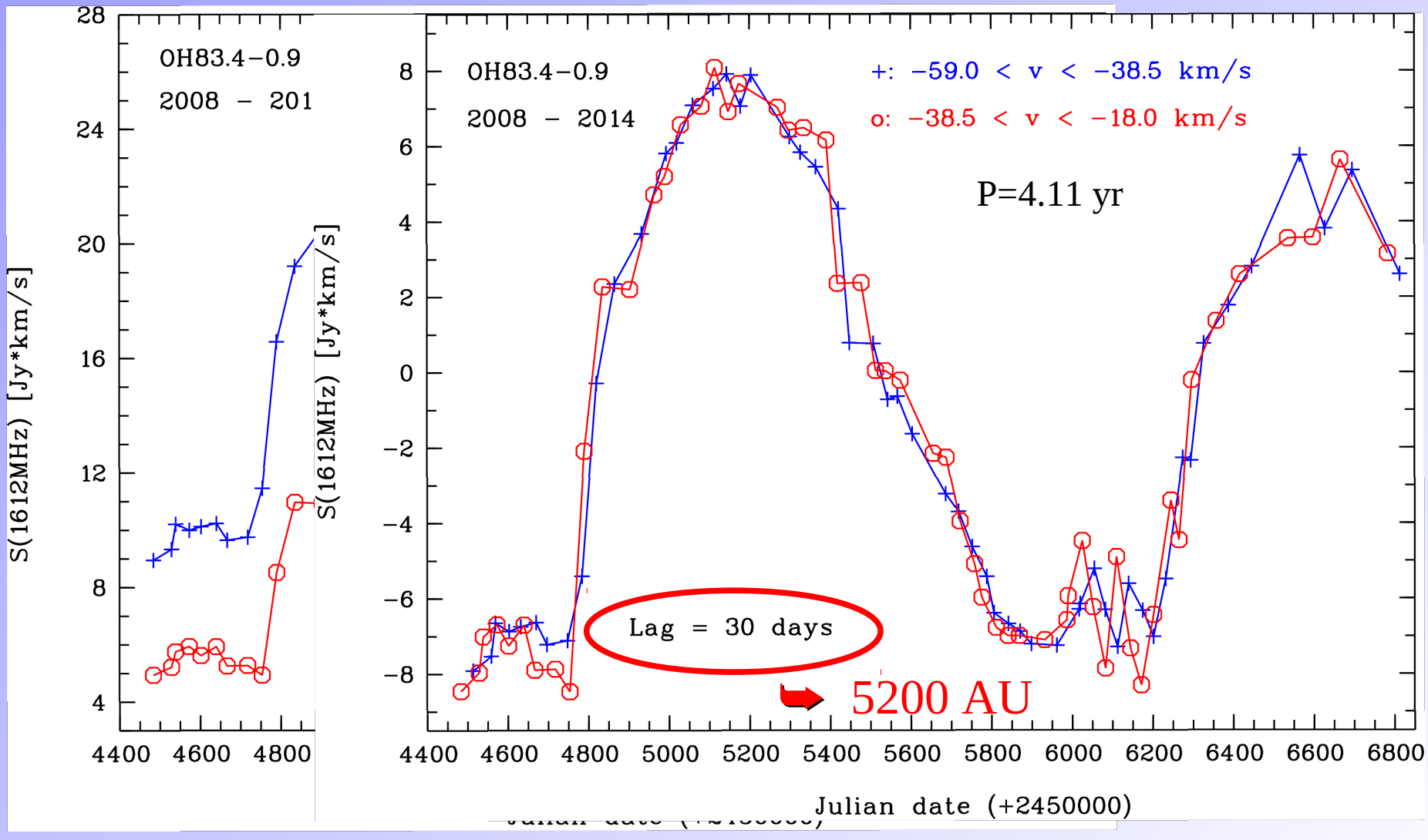
- Interferometric maps *(angular diameter)*
  - ➥ eMERLIN *(Feb. 2014)*

- Aims
  - ➥ new phase-lags *(50% from the 80's sample – 50% new sources)*
  - ➥ improved angular diameter *(detect the faint inter-peak signal – contrain shell (a)symmetry)*
  - ➥ contrain distance uncertainties of the method

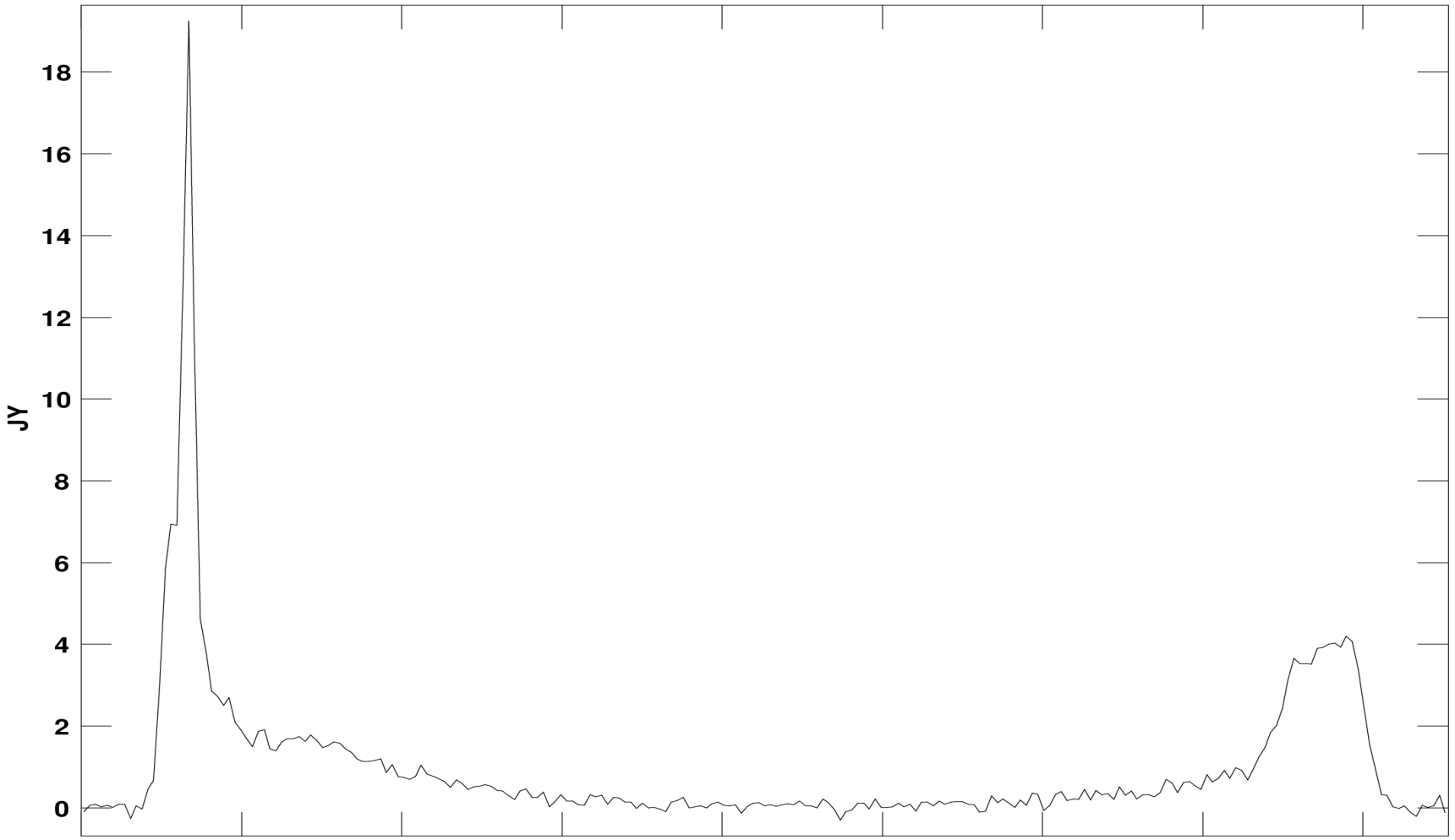
I- Linear diameter



I- Linear diameter

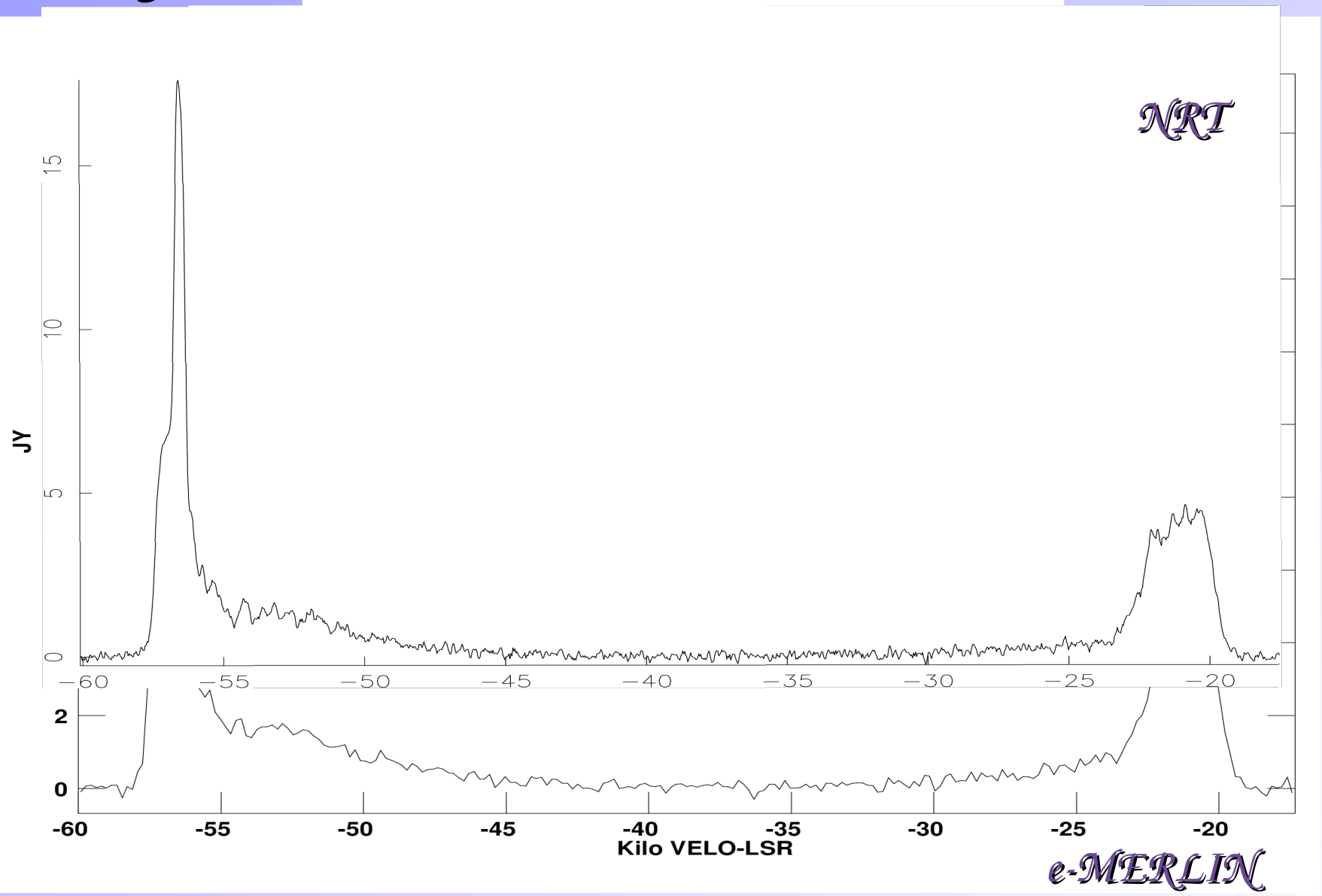


II- Angular diameter

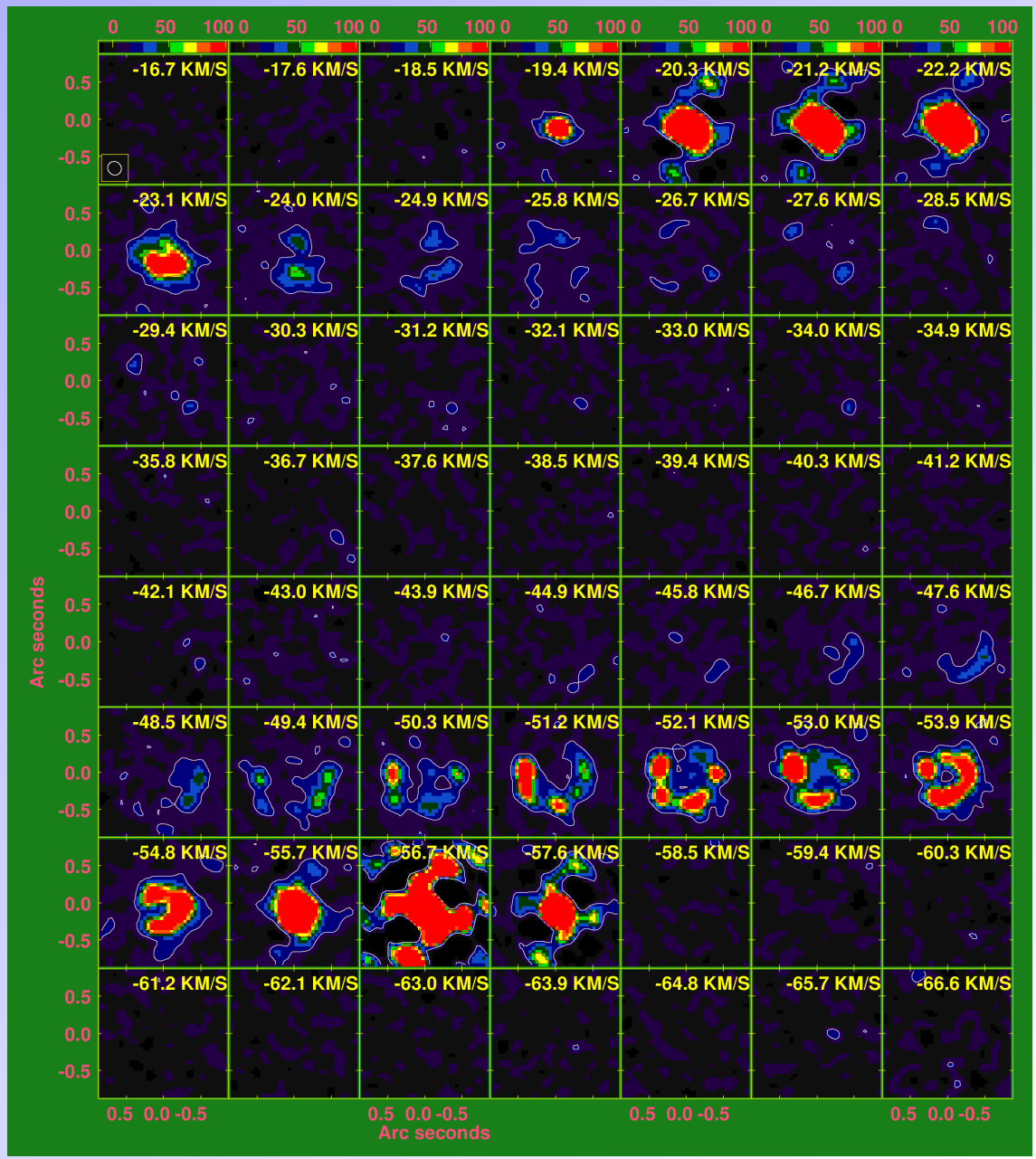


e-MERLIN

II- Angular diameter

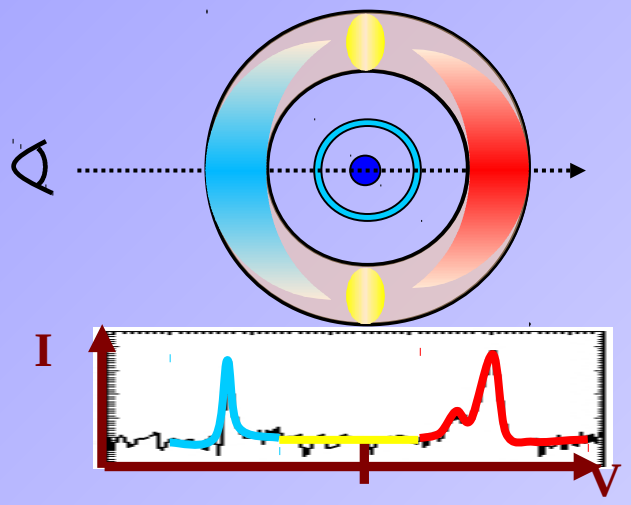


II- Angular diameter

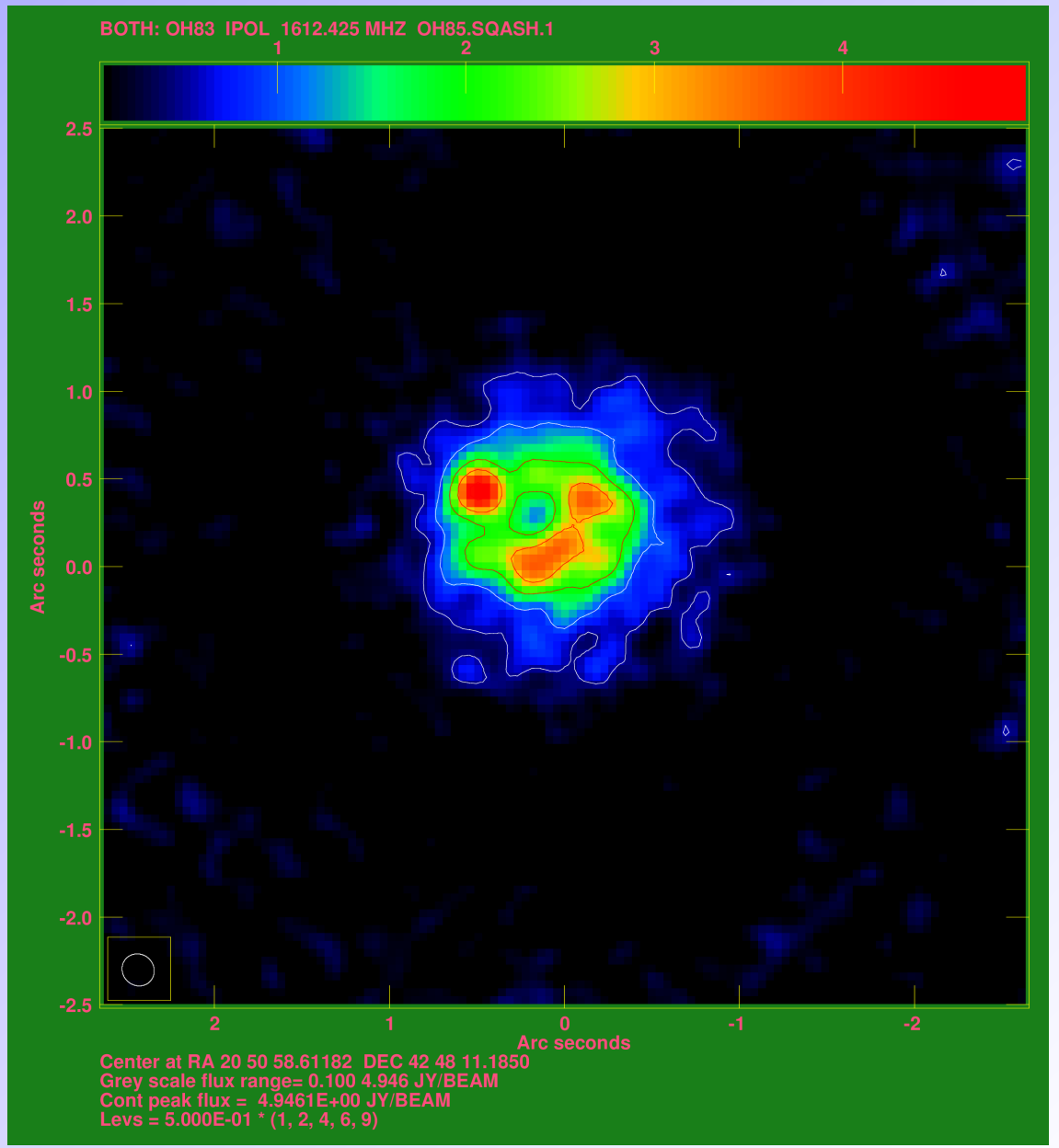


Channel maps consistent with thin-spherical-shell model

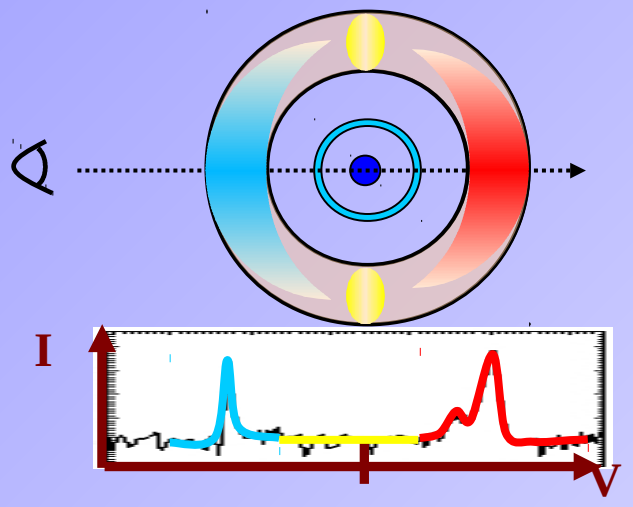
II- Angular diameter



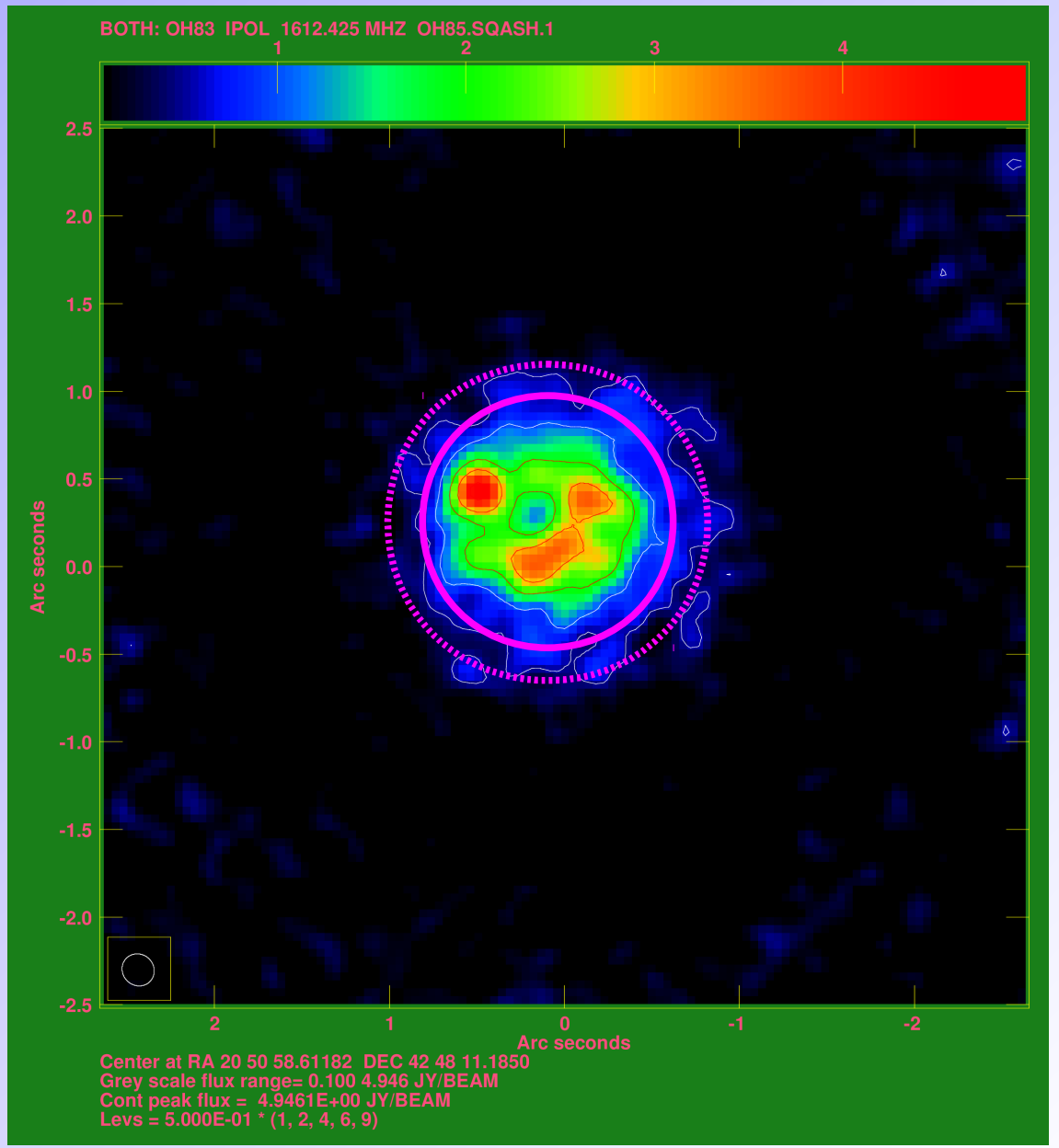
Integration over the inner part of the spectrum



II- Angular diameter



Diameter ~ 1.8 arcsec



I Linear diameter

&

II- Angular diameter

preliminary

Phase-lag distance

~ 3 kpc