Kinematics of the ionized stellar wind of the massive star MWC349A

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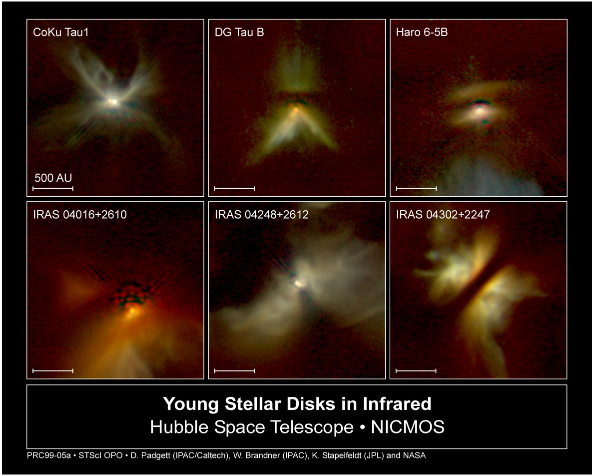
Motivation

- Low-mass star formation: ⇒ accretion of material through circumstellar disks



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- Massive stars play a key role in the galactic evolution
  - Ionize their surroundings

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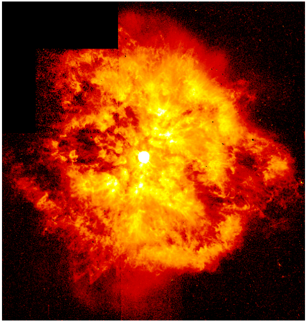

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- Low-mass star formation: $\Rightarrow$ accretion of material through circumstellar disks
- High-mass star formation: $\Rightarrow$?
- Late stages of high-mass stars : $\Rightarrow$?
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  - Ionize their surroundings
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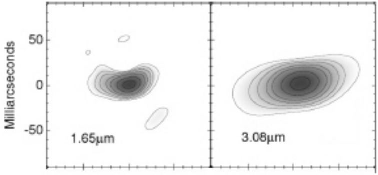
  - Supernova explosions

Motivation

- What do we know?
  - Evidence of circumstellar disks around massive stars.



Kraus et al. 2010

⇒ Explanation of why UC HII regions remain confined longer than expected

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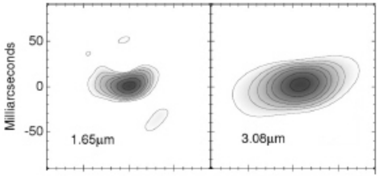

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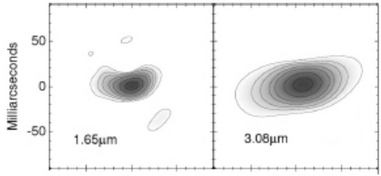

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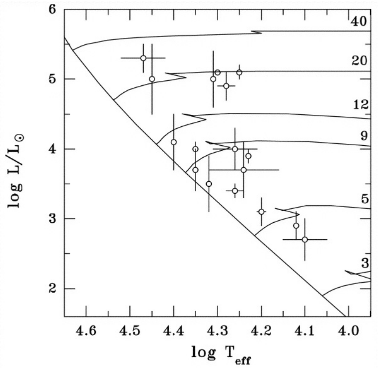
  - Late stages: a rich zoo of stars (LBV,W-R,Herbig Ae/Be,FS-CMa,sgB[e]). SgB[e] (supergiant B[e]) stars have circumstellar disks
- Motivation: understanding the kinematics of circumstellar disks and their associated outflows

MWC349A: a peculiar source

- $T_{eff} \sim 30000\ K$
- $L \sim 3 \cdot 10^4\ L_\odot$ (1.2 kpc, $A_v = 8.8 \pm 0.1$)



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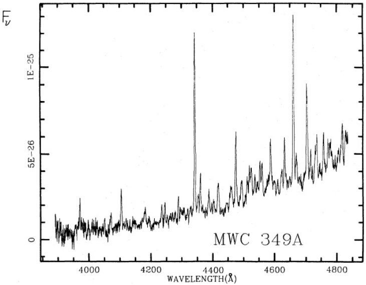

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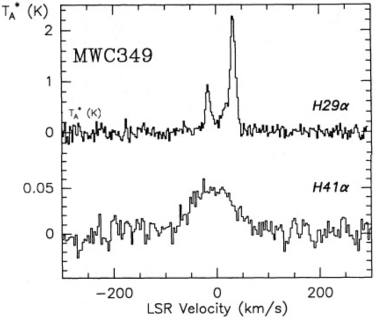
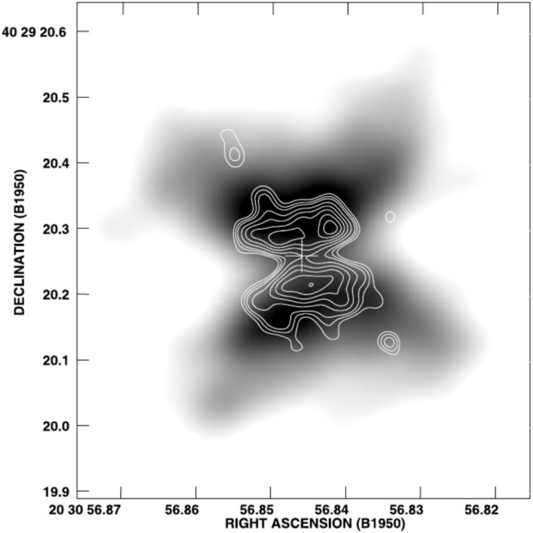
- The brighest source at radio-wavelenghs (at 6 cm)
- Maser and laser emission at Hydrogen recombination lines
    - Their high intensity makes possible to have a high spectral and angular resolution



Free-free radio-continuum emission morphology



Tafoya et al. 2004

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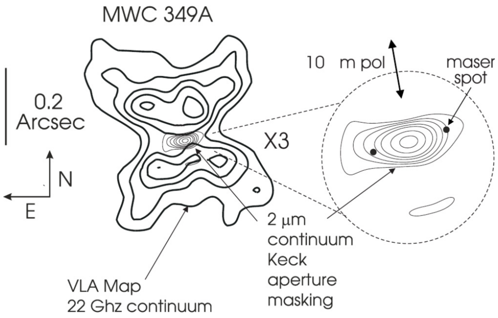

2.2 μm image. Danchi et al. 2001.

Radiative transfer model

- Kinematical structure study of the disk+ionized stellar wind system through modelling of the free-free continuum emission and hydrogen-recombination line emission (Báez-Rubio et al. (2011) in prep.)
- Model takes into account non local thermodynamics case $\Rightarrow$ explanation of the RRL maser emission

$$|T_B(\tau_\nu)| = T_{ex} e^{|\tau_\nu|}$$

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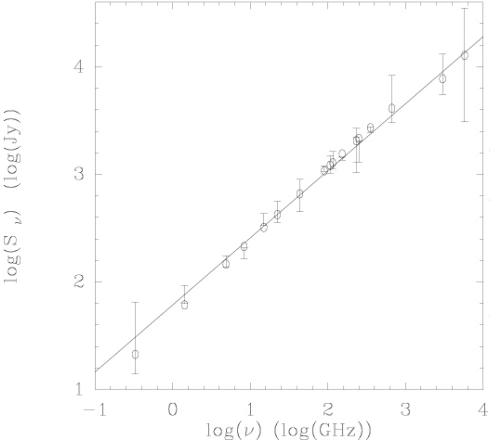
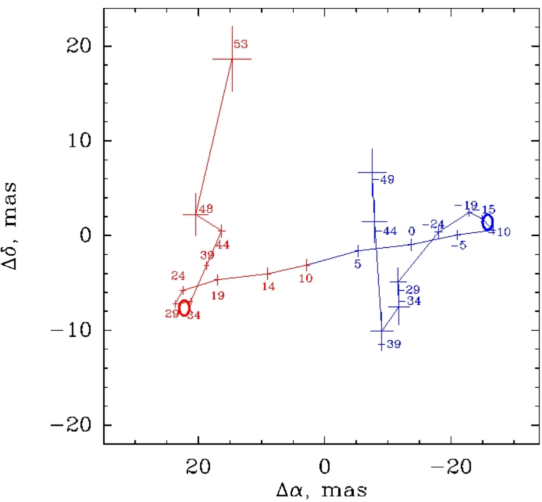
Spectral energy distribution (SED)



- Aperture, θ_a= 57º
- $N_e(r,\theta)$=$N_e(r$=1, θ=$\theta_a)\frac{e^{-(\theta_a-\theta)/20}}{r^{2.11}}$ $N_e(r$=6.7 AU, θ=$\theta_a)$=3.85·10^9 cm^{-3}
- T_{wind}=12000 K

H30α centroid map



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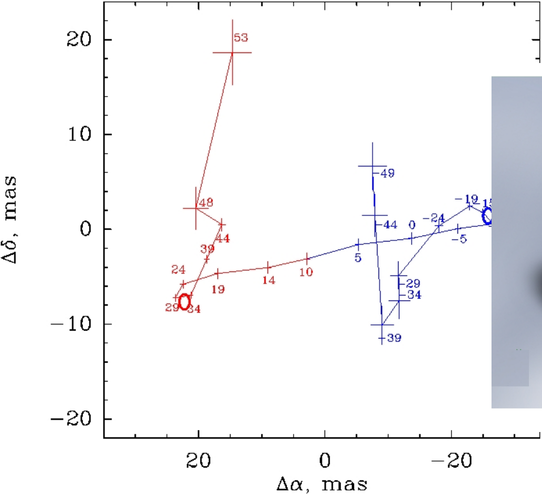
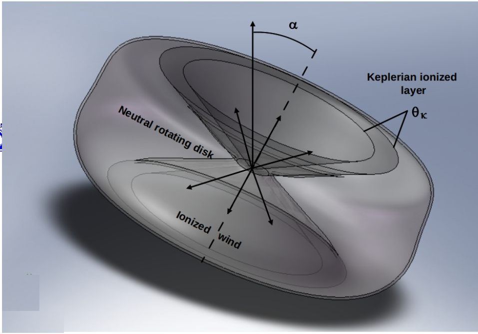
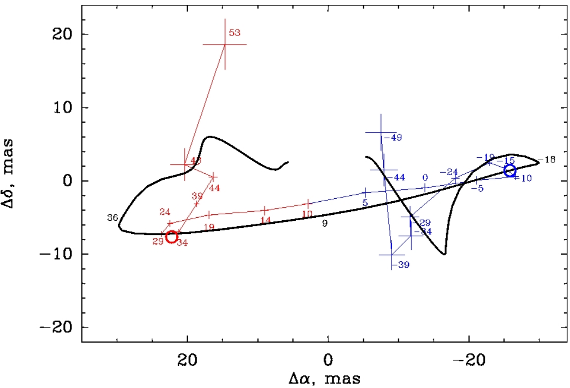


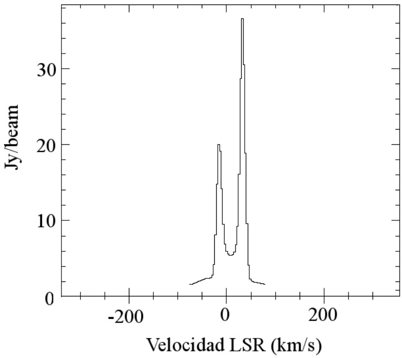


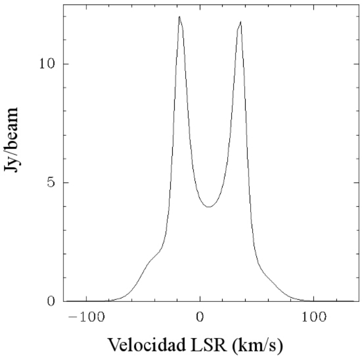
Model with an ionized outflow formed from very internal radius



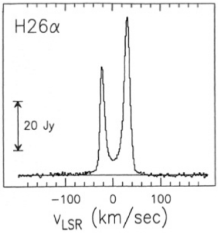
Parameter	Values
M	$\sim 40 M_{sun}$
α	8^{o}
θ_k	6.5^{o}
r_{min}	0.3 AU
r_{max}	130 AU
v_{exp}	60 km/s
T_{wind}	12000 K
$T_{disk\ rot}$	10000 k

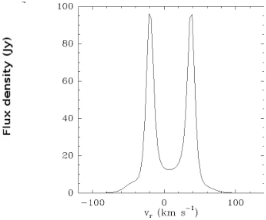
H30α RRL profile

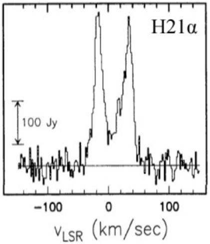


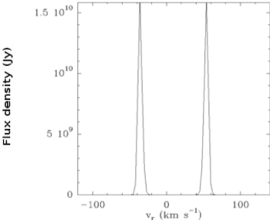


Kinematics of the inner regions









Line	Δv_{obs} (km/s)	Δv_{pred} (km/s)
$H26\alpha$	51.8 ± 0.1	61.5 ± 0.5
$H21\alpha$	50.1 ± 0.3	93.0 ± 0.5

Conclusions

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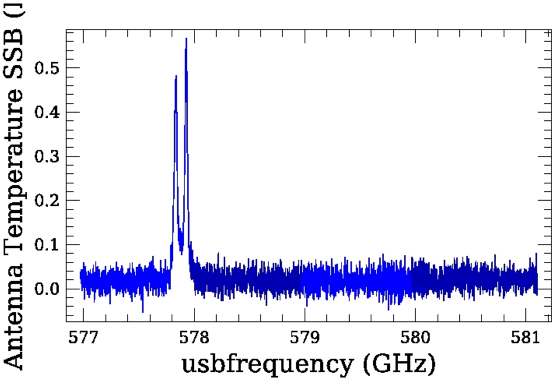
- Neutral disk is photoevaporating
- Stellar wind acceleration happens in short distances
- Stellar wind reaches the terminal velocity at very inner radius
- Need of theorical (magnetohydrodynamic) models

Prospects

- Study of the kinematics in the inner regions with Herschel
- Observations of new sources with maser emission



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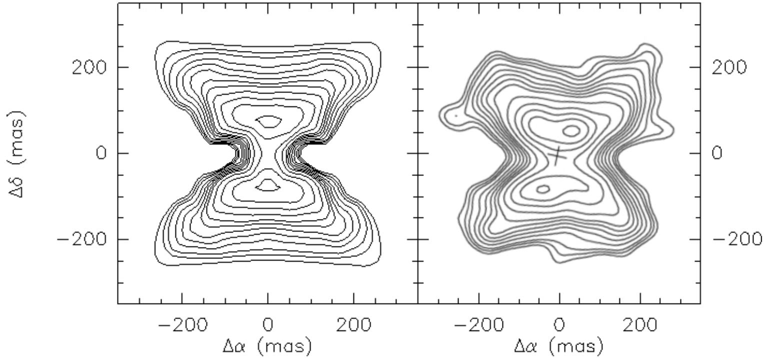
End

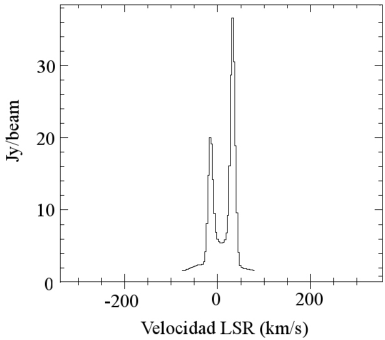
Thank you for your attention! :-)

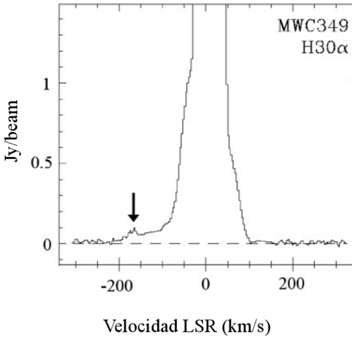
The important isn't the outside world, that apparently distant world full of massive stars, but how we can take advantage of what we learn from it to be able to go on overcoming each one of the challenges with which the life faces us up.

Radio-continuum map (1.3 cm)



H30α observational RRL profile





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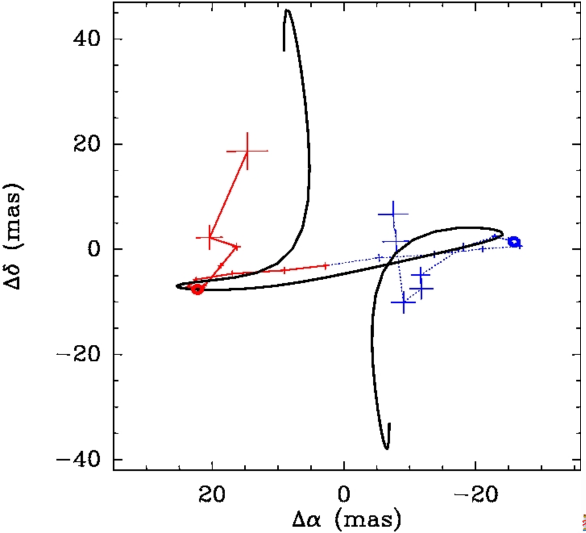
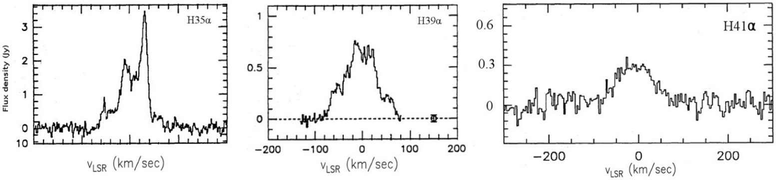
Model with an ionized wind expanding radially

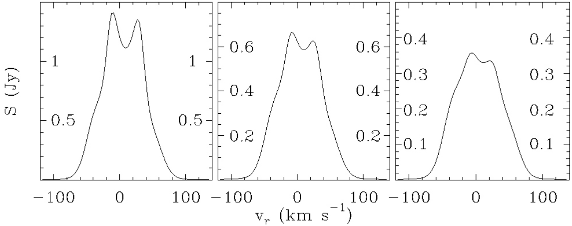


RRL profiles: $H41\alpha$, $H39\alpha$ and $H35\alpha$ RRLs

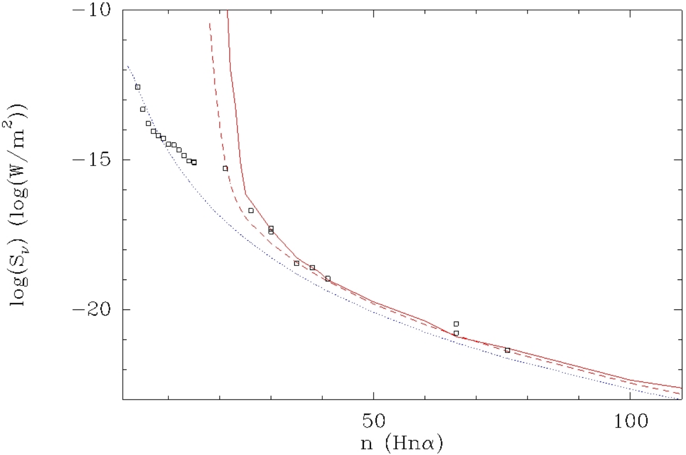
- Observational profiles of $H35\alpha$, $H39\alpha$ and $H41\alpha$



- Double peak (disk) in $H35\alpha$ ⇒ Pedestal (wind) in $H41\alpha$



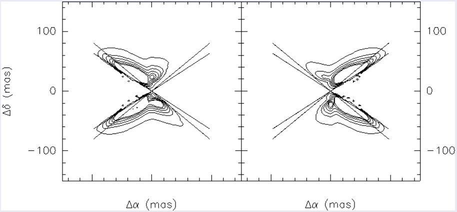
Integrated-line fluxes



- Stimulated emission even at H76α
- $21 < n < 41$: maser emission
- $7 < n < 21$: maser emission: saturation effects

Spatial distribution of emission

Maser spikes (km s^{-1})



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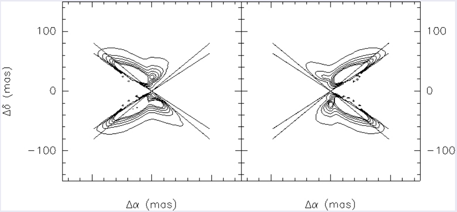
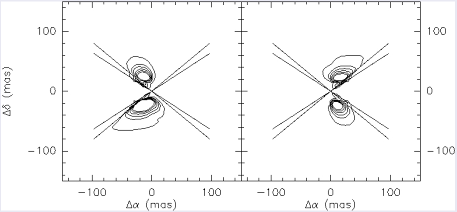


Outflow (km s^{-1})



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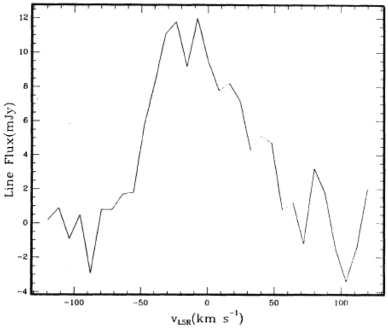

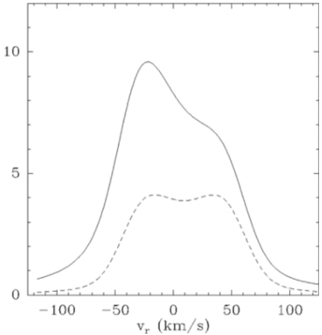

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