LOOKING FOR MOLECULAR GAS AROUND EVOLVED MASSIVE STARS

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19 diciembre 2017

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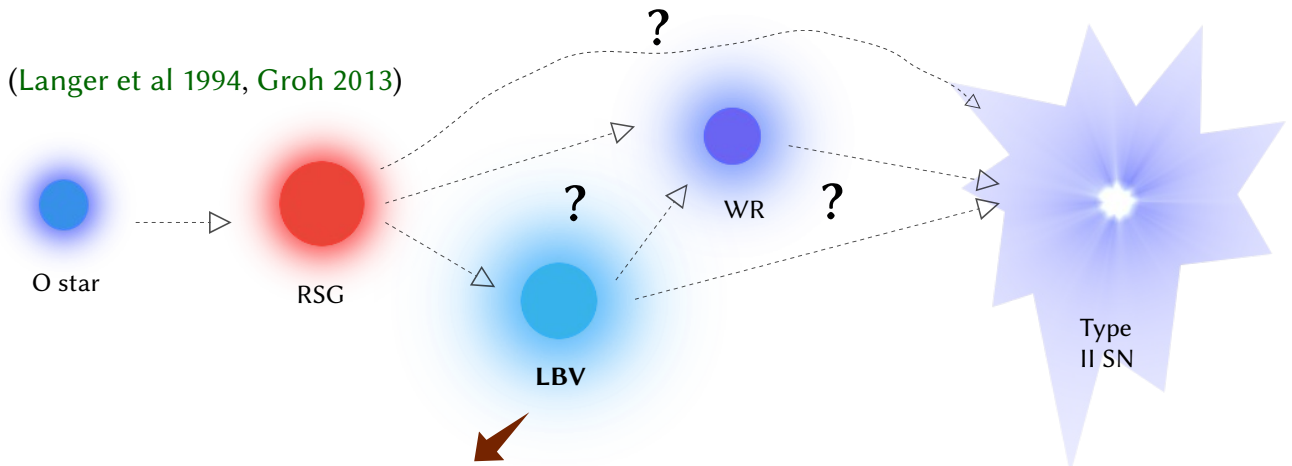
Context

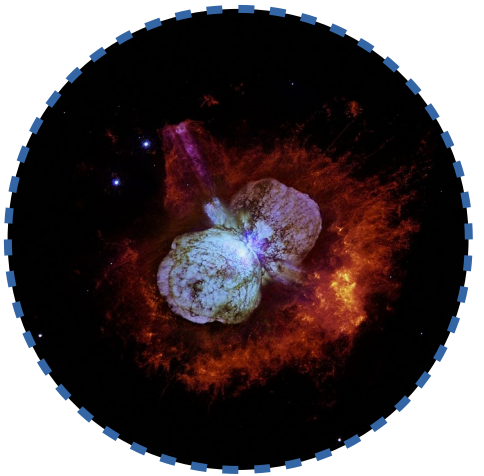
Massive stars **alter the ISM** during their whole life



LUMINOUS BLUE VARIABLE phase:

- Very **massive** hypergiants (M > 50 Msun)
- Very **hot** (T > 15000K)
- Very **luminous** (L > 10^5 Lsun)
- **Short-lived** (10^4 yrs)
- Highly **unstable** (eruptions) + high **mass-loss** rate (stellar winds)

Only a few in the galaxy



Eta Car is the best example

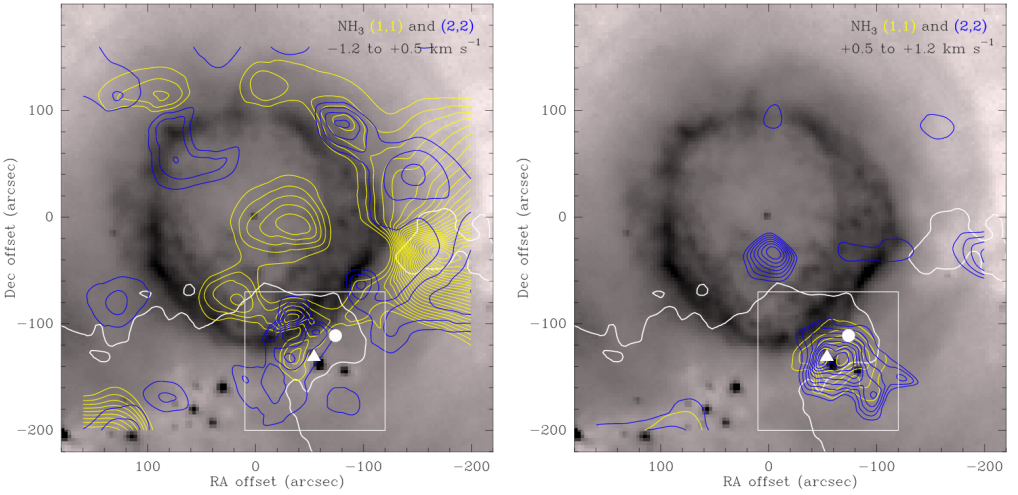
State of the art

There are many **open questions** regarding Evolved Massive Stars

- *How much EMS affect the ISM?*
- *How do EMS trigger star formation?*
- *What mechanisms drive the evolution of massive stars?*

LBVs and their **circumstellar molecular gas** can answer most of these questions

NH3 (1,1) and (2,2) shells in G79.29+0.46 (Rizzo et al. 2014)



Massive stars are **dust producers** → Molecular gas can **survive** around LBV forming **shells** →

Successful cases
- Eta Car
- AG Car
- G79.29+0.46
- …

→ **LOTS OF WORK TO BE DONE!**
(and here my thesis starts!)

Goals

Study the **interplay** between **evolved massive stars** and the **circumstellar material**

to

Achieve a **physical-chemical overview**
Measure kinetic energy and momentum **outputs**
Derive **timescales** & reconstruct **mass-loss history**

Two **complementary** strategies

Continuum observations
Warm gas and dust in the proximity of the star
=
Information on the radiation Mechanisms and gas/dust properties

Line observations
CO isotopologues and other high-density tracers
=
Information on gas physical conditions, dynamics and chemistry

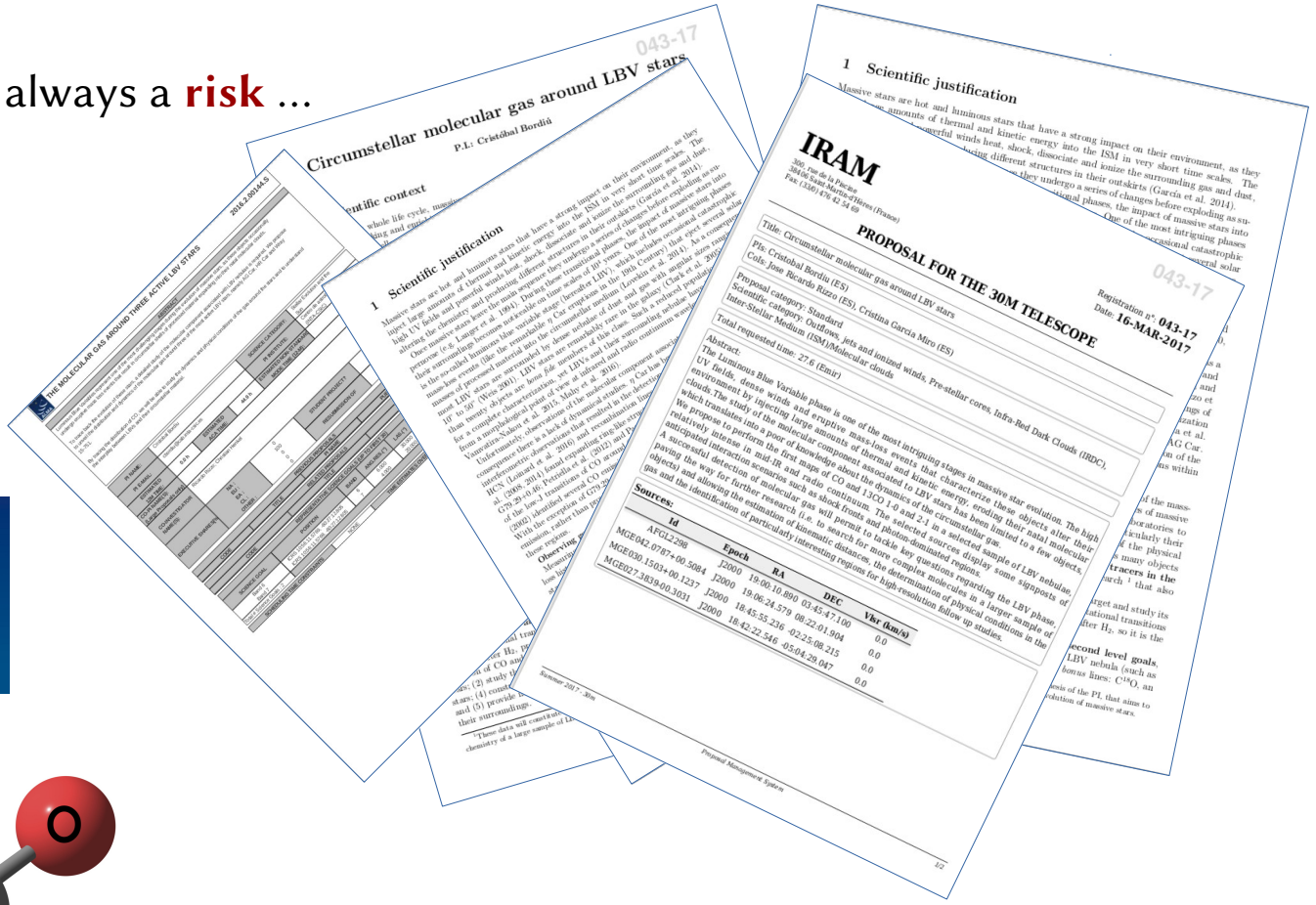
Projects · proposal preparation

A **first detection** experiment is always a **risk** ...

Facilities
- ✔ IRAM 30m
- ✔ ALMA

Targets
- ✔ MGE042.0707+0.5084
- ✔ AG Car
- ✔ AFGL2298
- ✔ HR Car
- ✔ Wray 751
- ✔ ...

Tracers
- ✔ CO isotopologues
- ✔ CN and HCN
- ✔ ...



... but also an **opportunity** to unveil new **science**

Projects ·Two accepted proposals at IRAM 30m

P043-17
Circumstellar molecular gas around LBV stars

EMIR observations of 4 LBV objects

Target lines: CO, 13CO and C18O at 1-3mm

July 2017

16h

P044-17
Continuum emission around LBV stars

1-2mm continuum observations of 5 LBV targets with the brand new KID receiver **NIKA2**

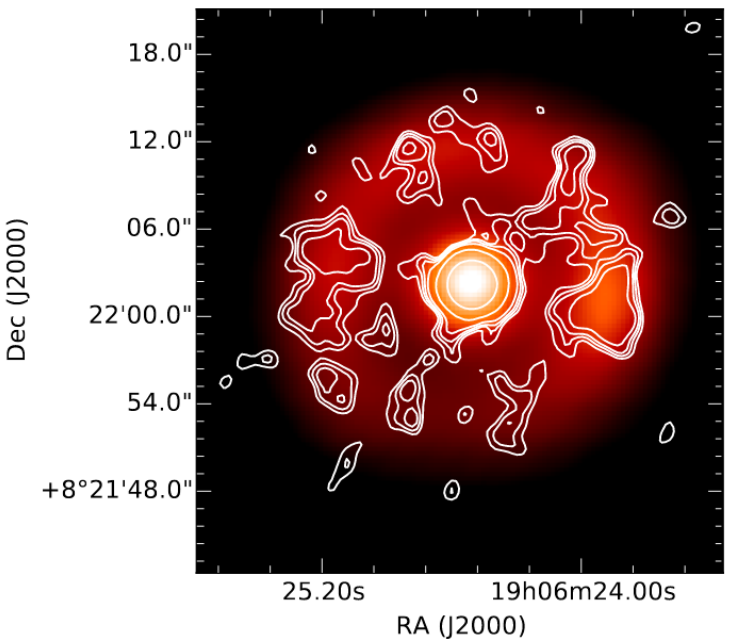
October 2017

5h

Project 043-17 · Results

MGE042.0787+00.5804 is a newly identified **LBV candidate**

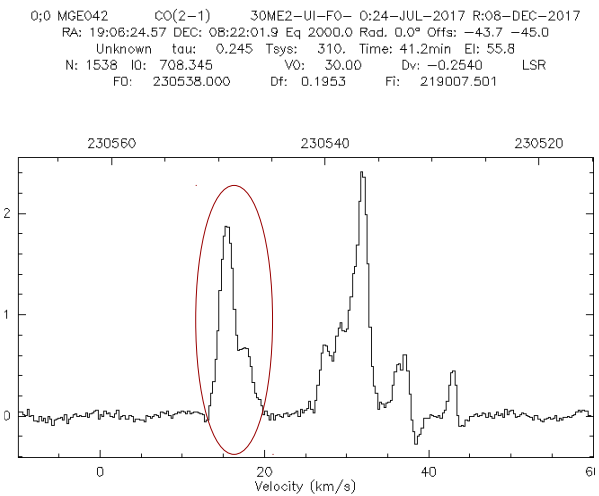
24 um image + VLA contours of
MGE042.0787+00.5804
(Ingallinera et al. 2016)

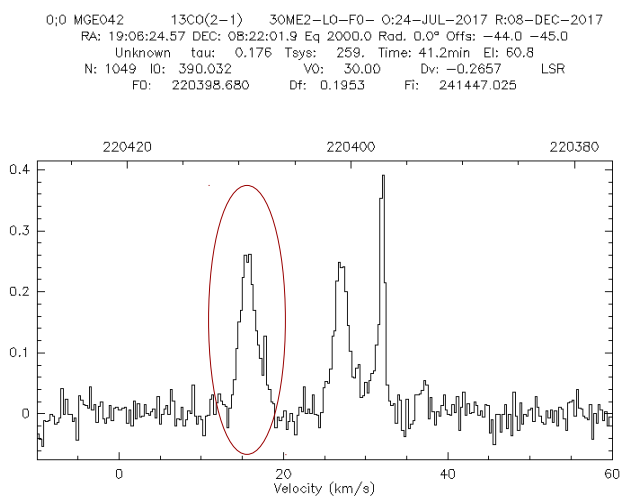


Features

Spherical dusty nebula
Varying spectral index

Detection of **CO** and **13CO** at 110 and 230 GHz

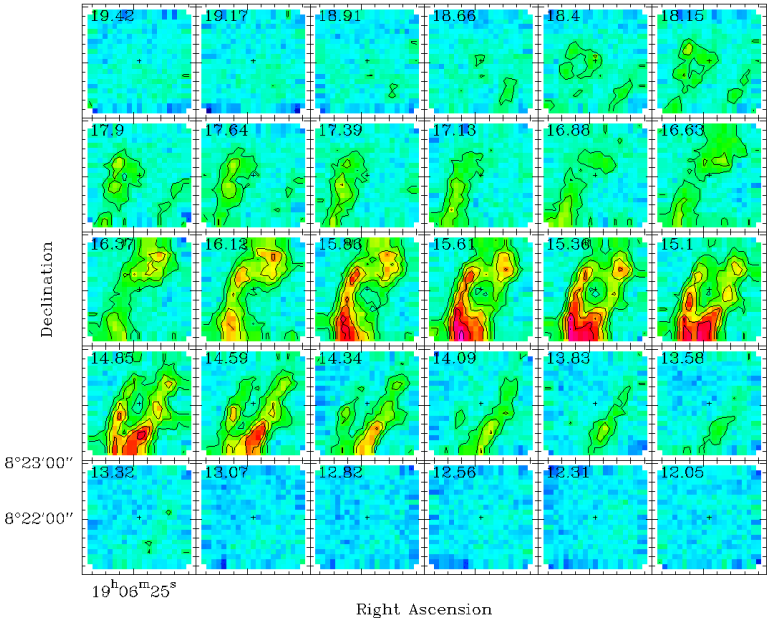




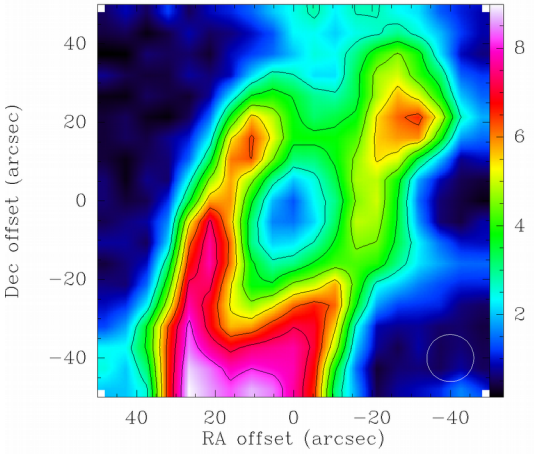
Project 043-17 · Results

An isolated **circumstellar structure** in the range 13-18 km/s

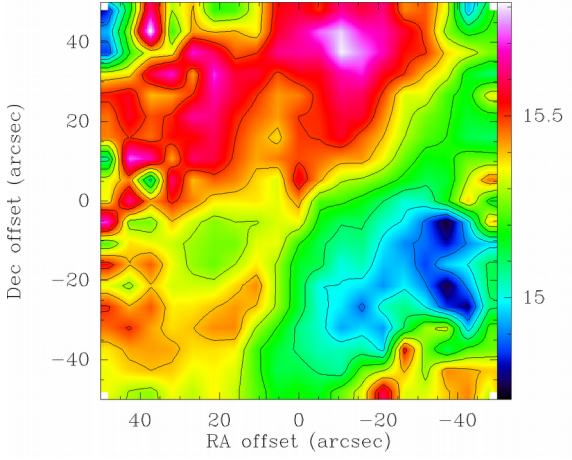
Channel maps CO(2-1)



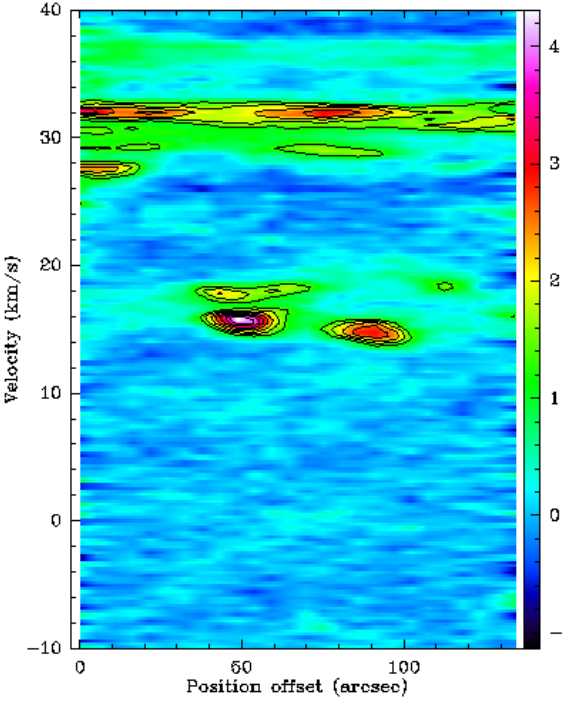
Line intensity CO(2-1)



Velocity field CO(2-1)



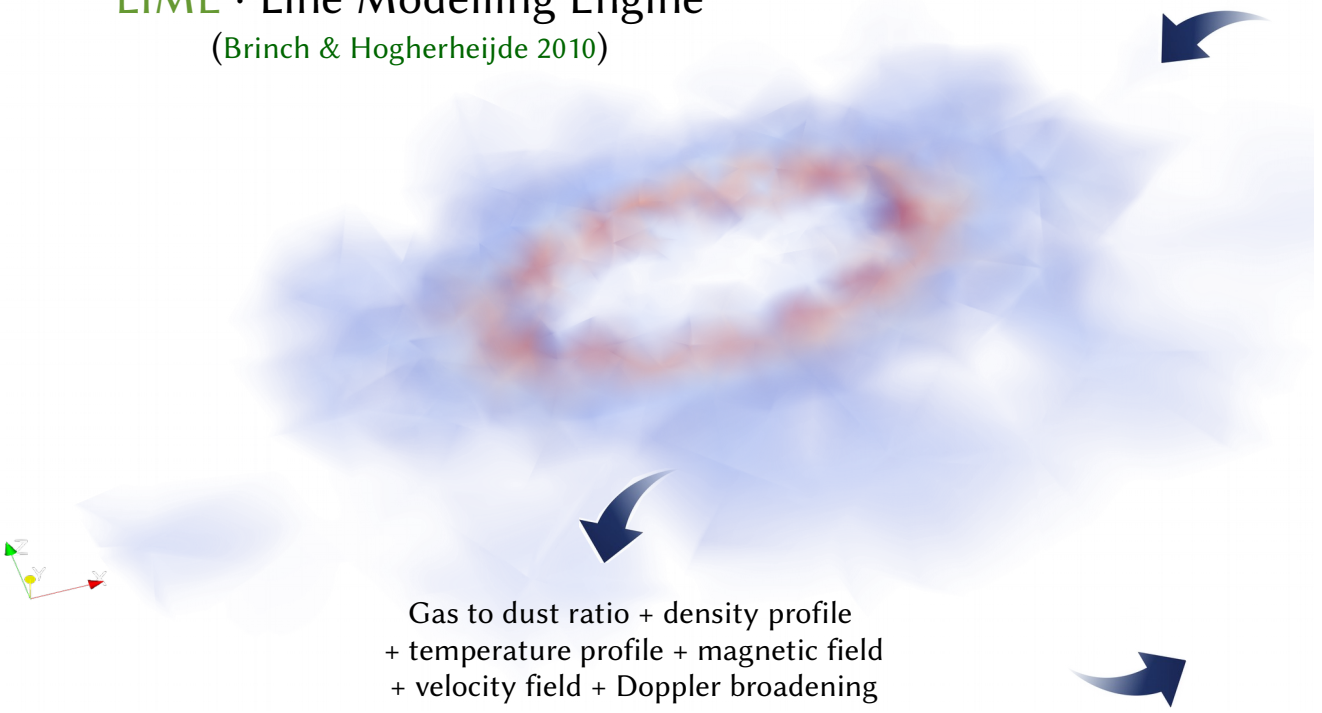
Position-velocity CO(2-1)



Project 043-17 · Interpretation

Observations are consistent with an **expanding torus**

LIME · Line Modelling Engine
(Brinch & Hogherheijde 2010)



Geometrical parameters
- Radius
- Inclination
- Position angle

+

Physical parameters
- n(H2)
- Xco
- Tkin
- Vexp

Gas to dust ratio + density profile
+ temperature profile + magnetic field
+ velocity field + Doppler broadening
=
FITS image

Convolution & **regridding**
to compare with data

Concluding remarks & ~~future~~ ongoing work

MNRAS **publication** (in prep.)

- Detection of molecular gas in M042
- Expanding structure consistent with an LBV event
- Radiative transfer model ⟶ parameters

Analysis of remaining P043-17 data

- MGE027 ⟶ a **puzzling** object!

Analysis of P044-17 data

- Hints of a **warm dusty shell** around G79.29+0.46

New **proposals** for summer '18

- Higher angular res. (interferometry)
- IRAM 30m, NOEMA, JCMT...
- New interesting objects (even WR stars?)

The end

Thanks for your attention!
Questions?