LOOKING FOR MOLECULAR GAS AROUND EVOLVED MASSIVE STARS

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Contents

✓ Context
✓ State of the art
✓ Goals
✓ Projects
✓ Project 043-17
  ✓ Results
  ✓ Interpretation
✓ Conclusions & future work
Massive stars **alter the ISM** during their whole life

**LUMINOUS BLUE VARIABLE** phase:
- Very **massive** hypergiants ($M > 50\, \text{M}_{\odot}$)
- Very **hot** ($T > 15000\, \text{K}$)
- Very **luminous** ($L > 10^5\, \text{L}_{\odot}$)
- **Short-lived** ($10^4\, \text{yrs}$)
- Highly **unstable** (eruptions) + high **mass-loss** rate (stellar winds)

Only a few in the galaxy

**Eta Car** is the best example
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

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!)

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

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

Features
Spherical dusty nebula
Varying spectral index

Detection of CO and $^{13}$CO at 110 and 230 GHz

24 um image + VLA contours of MGE042.0787+00.5804
(Ingallinera et al. 2016)
An isolated **circumstellar structure** in the range 13-18 km/s

Channel maps CO(2-1)

Line intensity CO(2-1)

Position-velocity CO(2-1)

Velocity field CO(2-1)
Observations are consistent with an **expanding torus**

**LIME · Line Modelling Engine**  
(Brinch & Hogherheijde 2010)

- Geometrical parameters
  - Radius
  - Inclination
  - Position angle
  
- Physical parameters
  - $n$(H$_2$)
  - $X_{co}$
  - $T_{kin}$
  - $V_{exp}$

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?