A WEAVE-Cygnus HR: an exploration of Cygnus-X

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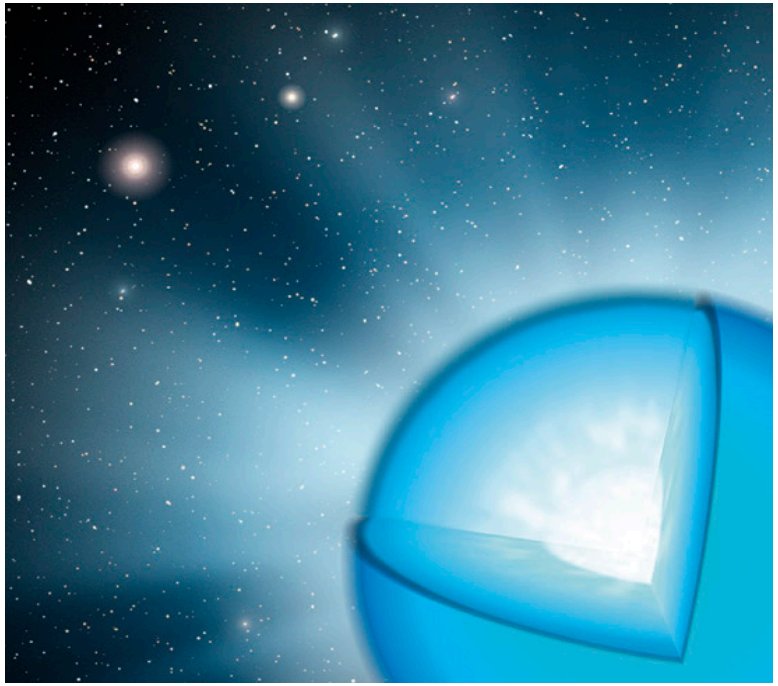
Abstract:

We present our project to explore the stellar content of the nearest Milky Way massive star forming región, Cygnus-X.
The main aim (but not the only one) is to understand the formation and evolution of single and multiple massive stars. Using the new WEAVE multifiber spectrograph attached to the 4.2m WHT and within the SCIP survey we will secure high resolution, high S/N, multiepoch spectra of massive stars born in the same region of the Milky Way. Combined with Gaia data, the analysis of the spectra will enlighten the different evolutionary scenarios, their past and future, and their relative weights.

The results of our project will constitute a cornerstone to interpret the observations in other regions of the Milky Way and nearby galaxies.



The nearest massive star forming region: Cygnus X

Cyg-X is the most powerful star forming region at a relatively close distance (d~1.5 kpc). It is a very young and complex región, containing several rich OB associations (mainly Cyg OB1, CygOB2, Cyg OB3 and Cyg OB9).

It is an ideal testbed for our theories about:
→ Star formation
→ Structure and evolution of massive stars
→ Properties of gas and dust in young regions
→ The interplay between stars and the ISM
→ Dynamics and kinematics of OB associations and stellar groups

The región has been studied at all wavelegths, but there has been no extensive spectroscopic survey of the stellar population in the optical to obtain accurate stellar parameters, abundances and velocities

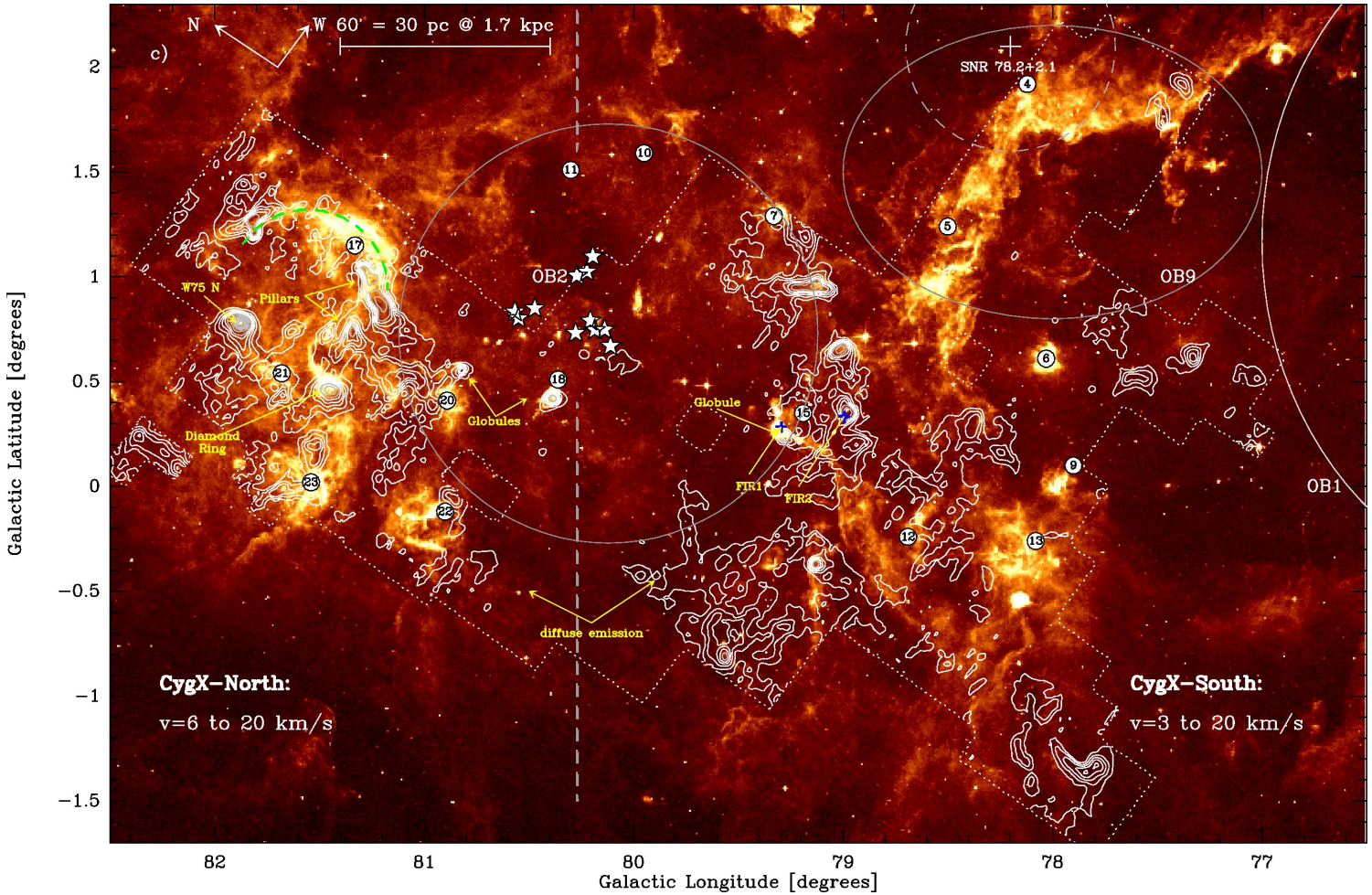


Fig. 1: (from Schenider et al., 2006, A&A 458, 855) A view of a small zone of Cygnus X centered in its richest OB association Cyg OB2, that contains more tan 80 known O stars. The whole región occupies over 20 degrees in Galactic longitude, but the OB associations extend from 71º to 81º approximatelly.

WEAVE: a perfect instrument for massive stars in Cygnus X

WEAVE (WHT Extended Aperture Velocity Explorer) is a wide-field multi-fiber (and IFU) spectrograph for the 4.2m William Herschel Telescope. It is specially designed to conduct spectroscopic surveys. It has a 2° FoV where 960 (Plate A) or 940 (Plate B) are placed.
It has two arms, with a Low Resolution mode (R=5000, Δλ=366-606 + 579-959), a High Resolution mode (R=20000, Δλ=404-465 or 473-545 + 595-685), 20 deployable mini-IFUs and one Large IFU.

2 deg ϕ
LR, HR, mini-IFU, LIFU modes

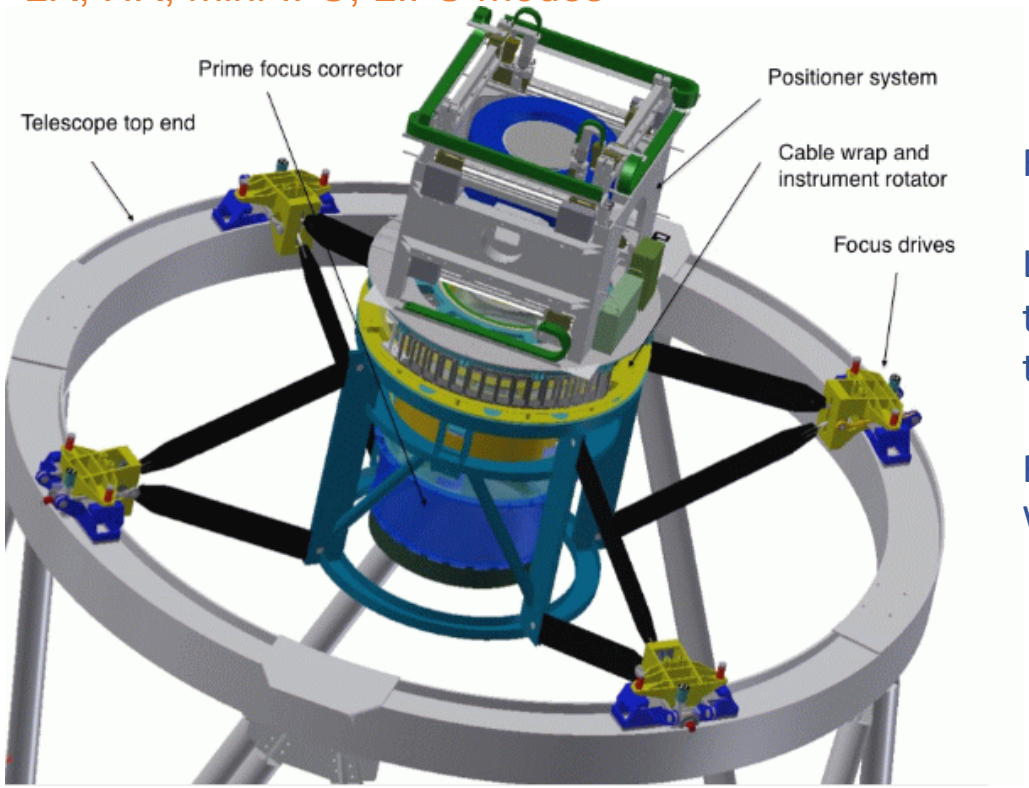
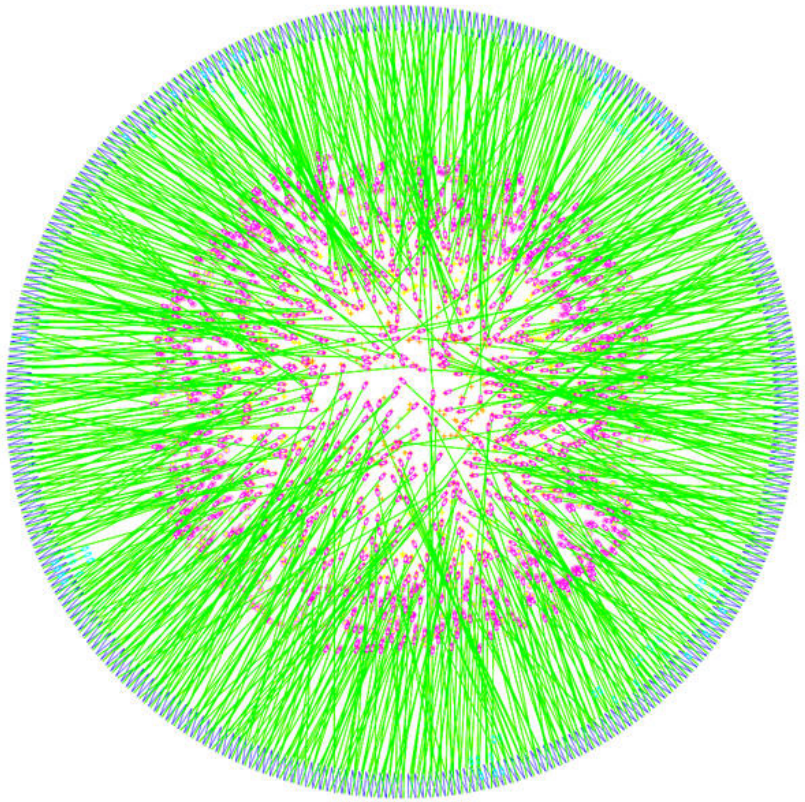


Fig. 2.-

Left: representation of the WEAVE telescope on top of the WHT

Right: Example of the WEAVE fiber layout

960-940 fibers
1 hour to configure the plate



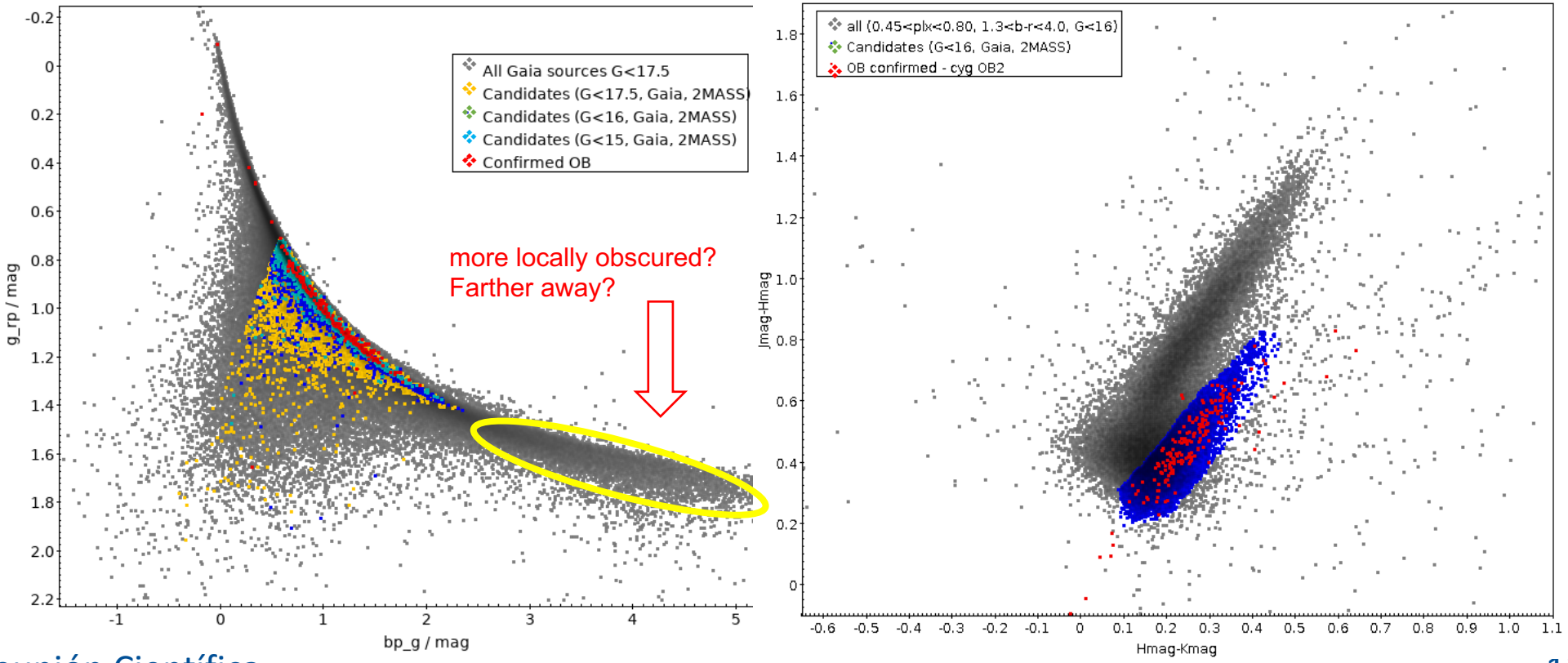
- Our Project is driven by the study of the massive star population of Cygnus-X to explore the different scenarios of single and massive star formation and evolution.
- We want to secure high S/N massive star spectra at the highest WEAVE resolution in the star-forming Cygnus region to:
    1. Obtain rotational velocities and their distributions, especially in the low vsini region (< 100 km/s)
    2. Determine binary fractions and stellar multiplicity
    3. Determine accurate stellar parameters, particularly gravity, improving those obtained from the LR survey and allowing more precise radii and masses with the help of Gaia data
    4. Obtain accurate abundances and spatial abundance patterns for O3-B9 stars in the region for targets with 11<B<16.5
    5. Determine the kinematical and dynamical status of the stars in the Cygnus region
- But these are not the only targets
    - BAF stars: age extensión, ZAMS anchor point, kinematics, dynamics, structure
    - BA stars: TAMS characteristics
    - PMS and YSO: kinematics, star formation activity
    - ISM: abundances, kinematics
    - Individual targets (Cepheids, withe dwarfs)

Selecting massive stars in Cygnus X for WEAVE

- Target selection is made following Gaia and 2MASS. We use Cyg OB2 as a proxy
  - $0.45 < \pi < 0.80$
  - $1.3 < Bp\text{-}Rp < 4.0$

  } From Berlanas et al., 2019, MNRAS 484, 1838
  - $G < 16$ Given by WEAVE efficiency
  - No RV measurements in Gaia catalog

Fig. 3- Left: Gaia Color-Magnitude diagram in Cyg OB2. Known OB stars (red points) follow a well defined line. For fainter G magnitudes the scatter increases. Right: we use 2MASS to confirm that the candidates follow the expected trends



Massive stars in Cygnus X with WEAVE

Fig. 4- Our preliminary target selection. Blue points indicate our blue massive star candidates and red points the known OB stars in the Cyg OB2 área. Blue circles mark the OB associations. Red circles are the WEAVE pointings or tiles (for some of them, we foresee two different fiber configurations). Each fiber configuration will be observed between 10 and 13 times, allowing for high S/N and multiepoch information.

Other targets like Red Supergiants,A-F stars or interstellar medium will be added