Testing photoevaporation of circumstellar disks in the young open cluster NGC 6611

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1. Introduction

We present a multi band study of the stars with circumstellar disk in the young open cluster NGC 6611. We aim at studying the influence of UV radiation emitted by massive stars on the evolution of nearby disks. The young open cluster NGC 6611, in the Eagle Nebula, is a suitable target for this kind of study thanks to its large population of massive members (more than 50 with spectral class earlier than B5) distributed irregularly in the central region of the cluster. To reach our objective, we compiled a multi band catalog using optical WFI observations in BVI bands (to determine stellar properties), 2MASS catalog and IRAC data from GLIMPSE survey (to detect disk presence) in a region of 33′×34′ centered in the cluster, and a Chandra X-ray observation available in the central region of 17′×17′ (for membership criterion).

2.Cluster properties

Using X-ray emission as membership criterion (especially useful for Class III stars, see Fig. 1), in Guarcello et al. (2007) we have determined:

• a distance of 1750 parsec, thanks to the fact that the radiation from background stars is strongly absorbed by the Eagle Nebula;

• an age interval of 0.1-3 Myrs, obtained fitting the isochrones to the locus of bright X-ray sources;

• an average extinction for cluster members (A_V=2.6^m) and an anomalous reddening law (R_V=3.27);

• a core radius (1.4±0.1pc, see Fig. 2) and a relaxation time for the core equal to 4.2 Myrs, greater than the age of the pre-main sequence population.

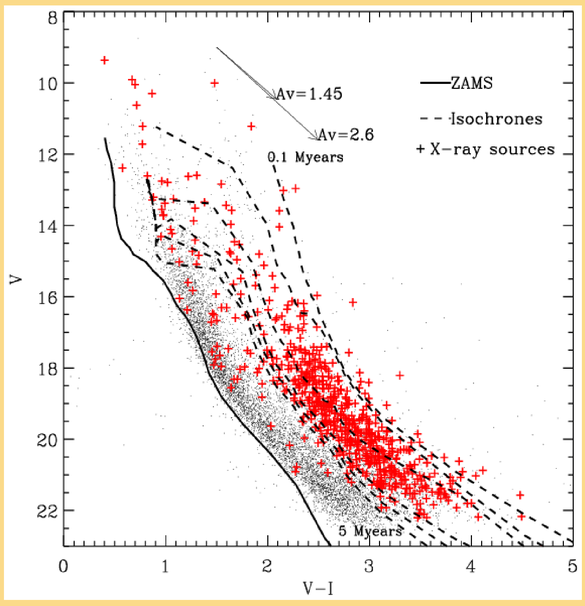

Fig 1: V *vs* V-I *diagram of the stars in 33′×34′ Field of View (FOV). ZAMS and isochrones are from Siess et al. (2000), while the extinction vectors were obtained from the reddening law from Munari & Carraro (1996).*

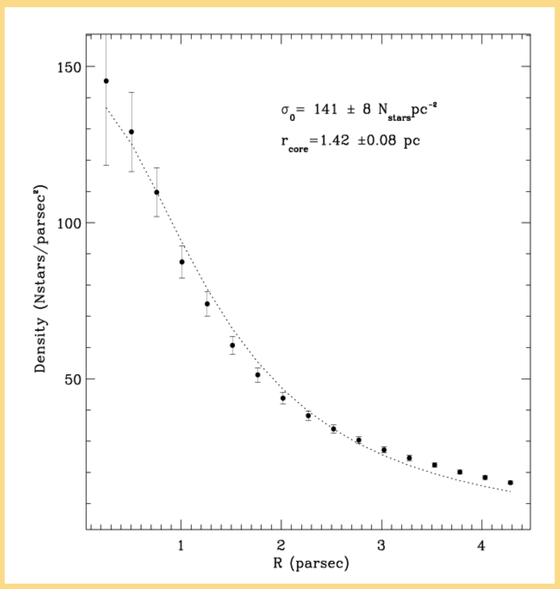

Fig 2: *Observed radial density profile of the cluster (points) and best-fit 2-parameters profile (dotted line) from King (1966)*

3. Selection of stars with circumstellar disk

• We identified the stars with circumstellar disks thanks to the infrared excesses, that were detected by suitable free-reddening optical-2MASS and optical-IRAC color indices, defined in order to be more negative for stars with excesses (e.g. Fig.3):

$$Q_{ABCD} = (A - B) - (C - D) \times E_{A-B}/E_{C-D}$$

where A, B, C and D are four generic magnitudes in four different bands and E_{A-B} and E_{C-D} are the corresponding reddening. With this method, we identified 360 candidate members with disk in the 33′×34′ WFI FOV.

• With the Color-Color IRAC diagram (see Fig. 4) we confirmed the selected members with disk and we identified 110 more stars with circumstellar disk, 64 of which are classifiable as Class II stars.

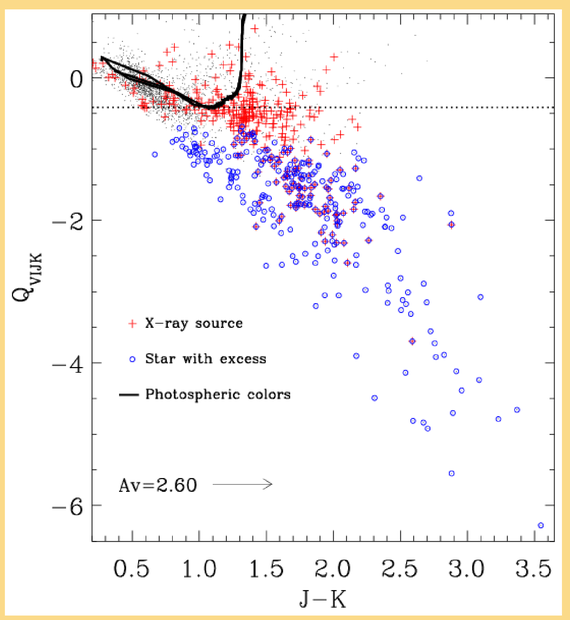

Fig 3: D*iagram used to identify stars with excess in K band, i.e. stars with the Q_{VIJK} index smaller than the photospheric limit (dotted line) more than 3σ.*

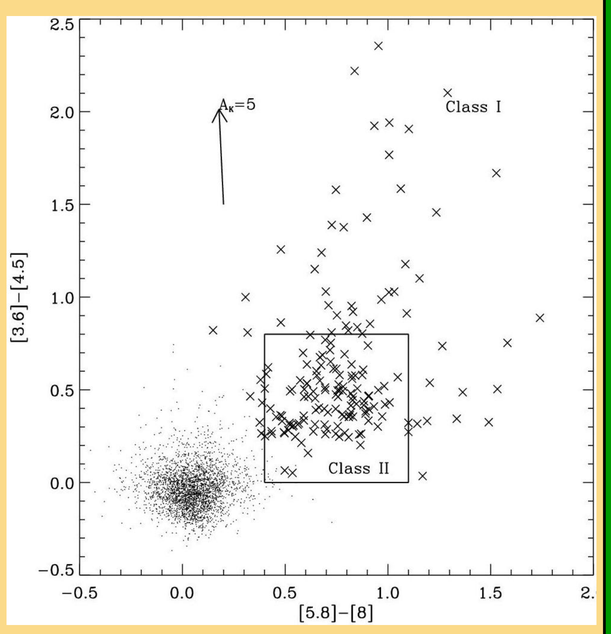

Fig 4: *IRAC Color-Color diagram of the stars in 33′×34′ WFI FOV. The box delimits the locus of Class II stars (Allen et al., 2004). The reddening vector was obtained from the reddening law of Flaherty et al. (2007)*

4. Spatial distribution

In the central 17′×17′ region, we calculated the UV flux emitted by massive members and incident on the stars with and without disk. The histogram in Fig. 5 shows the evident trend of disk frequency (ratio between the numbers of stars with disk and the total number of cluster members) at increasing of UV incident flux.

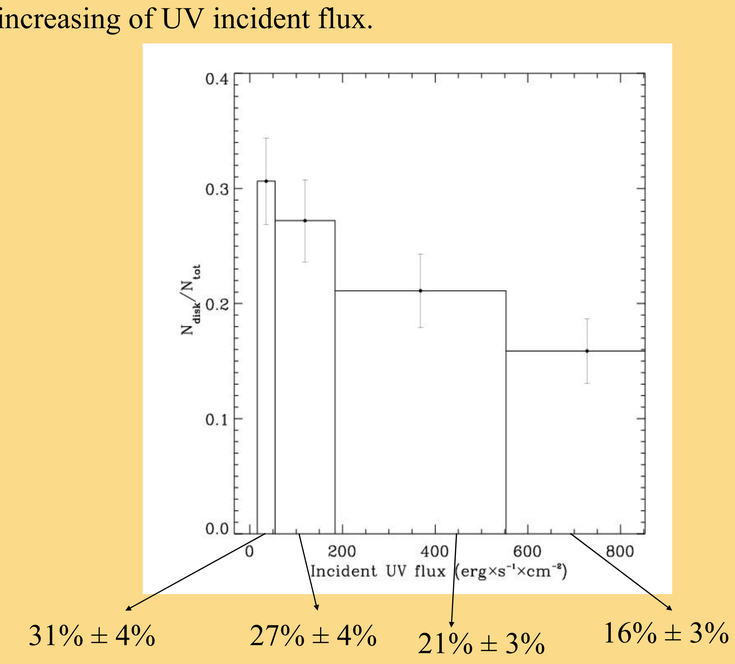

Fig 5: *Histogram of disk frequency in the central region of NGC 6611 versus the incident UV flux*

The histogram shows as the disk frequency decreases for increasing of incident UV flux, i.e. increasing the distance from massive stars. Considering that the central region is not yet relaxed and that we have no evidence of sequential star formation, we conclude that this result is in agreement with the hypothesis that **the evolution timescales of the circumstellar disks in NGC 6611 may be modified by the photoevaporation process**.

5. SED analysis

We studied the Spectral Energy Distributions (SEDs) of selected members with disk, using the theoretical models of stars with envelope and disk developed by Robitaille et al. (2007). SED analysis suggested how the photospheric flux scattered along the line of sight by circumstellar material alters significantly the stellar optical colors. Significant scattering of photospheric light and optical veiling can be invoked to explain the optical colors of ~90 members with disk, which V-I color is bluer than 5 Myr isochrone in the diagram in Fig. 1 (Guarcello et al. 2008, in preparation). The presence of a significant amount of scattered light at optical wavelenghts allowed also to identify some members with disks which SEDs are compatible with disk with a large inner radius, normally non detectable by other NIR diagnostics. Fig. 6 shows the SED of a star with disk which optical emission is dominated by scattered light.

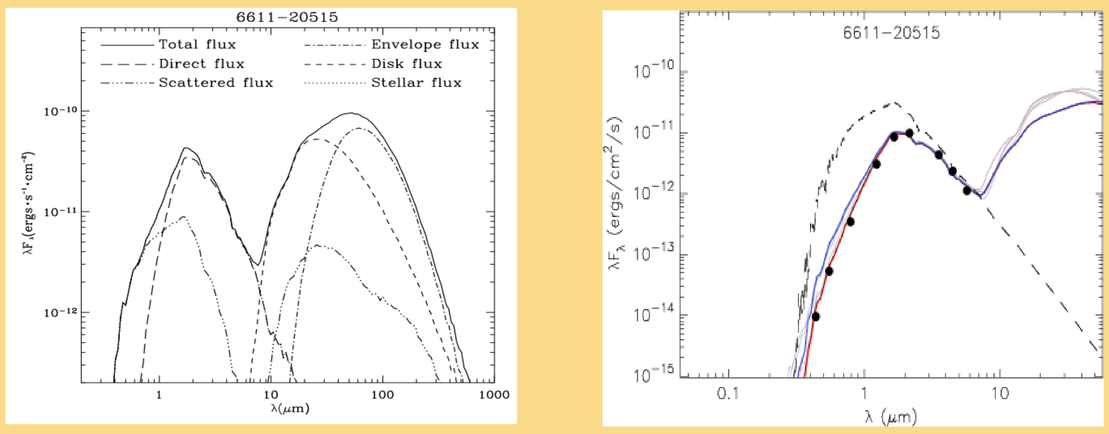

Fig 6: *The right panel shows the observed SED (point) of a star with disk, while the lines are the best-fit models and the dotted line is the photospheric models; the left panel shows the different component of the best-fit SED.*

Acknowledgements: M.G. acknowledge support from the Ministero dell'Università e Ricerca Scientifica e Tecnologica; G.M. acknowledge the contribution by project funded by European Commission contract MTKD-CT-2004-002769; both acknowledge the ASI INAF I/088/06/0 contract.

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