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The unusual behavior of the Hydrogen emission line from a young star in RCW 36

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Abstract. Stars are the most widely recognized astronomical objects and represent the most fundamental building blocks of galaxies. In this work we are researching about a particular young star (ESO-Hα 2429) in RCW 36, a small HII region located in the Vela Molecular Ridge. This region was surveyed at the SOAR telescope, in Chile, using slitless spectroscopy and an Hα filter with the Goodman spectrograph, with the goal of searching for emission-line stars, as part of a larger survey on star-forming regions. The objective of this work is to try to discover the reason why this young star has a hydrogen emission line so different from other young stars. This work is still in progress, but we propose that accretion and/or ejection processes are occurring at very high velocities.

Resumo. As estrelas são os objetos astronômicos mais amplamente reconhecidos e representam os blocos fundamentais mais importantes das galáxias. Neste trabalho, estamos pesquisando uma estrela jovem em particular (ESO-Hα 2429) em RCW 36, uma pequena região HII localizada na Nuvem Molecular de Vela. Essa região foi estudada por meio do telescópio SOAR, no Chile, usando espectroscopia sem fenda e um filtro Hα com o espectrógrafo Goodman, com o objetivo de procurar estrelas com linhas de emissão, como parte de um levantamento mais amplo de regiões de formação estelar. O objetivo deste trabalho é tentar descobrir a razão pela qual esta estrela jovem possui uma linha de emissão de hidrogênio tão diferente de outras estrelas jovens. Este trabalho ainda está em andamento, mas propomos que processos de acreção e/ou ejeção estejam ocorrendo a velocidades muito altas.

Keywords. Accretion, accretion disks – Stars: formation.

1. Introduction

Stars are giant balls of hot gas, mostly hydrogen, with some helium and small amounts of other elements, and they form inside relatively dense concentrations of gas and interstellar dust known as molecular clouds. A molecular cloud is a region containing cool interstellar gas and dust left over from the formation of the galaxy and contains mostly molecular hydrogen. When the denser molecular cloud regions collapse under their own gravity, the star formation process starts and it takes millions of years. As long as they collapse, the central regions break up into pieces that form protostars. Protostars are objects that will be young stars if they have sufficient mass or brown dwarfs if not. One characteristic of young stars is the presence of emission lines, mainly of Hydrogen, from the shock of the material that accumulates in the protostellar disk and falls into the star.

In this work we are studying about a young star identified by Petterson (2008) as ESO-Hα 2429 in the RCW 36 region that has a hydrogen emission line wider than other young stars.

2. RCW 36

RCW 36 (or Gum 20) is a small HII region in the Vela Molecular Ridge and is one of the sites of massive-star formation closest to the Solar System, with distance of approximately 700 parsecs. The most massive stars in the star cluster are two stars with late-O or early-B spectral types and this region is also home to objects with Herbig-Haro jets, HH 1042 and HH 1043. The region is associated with a dense molecular cloud (Yamaguchi et al. 1999) and harbors a massive infrared cluster (Massi et al. 2004 and Baba et al. 2004).

Star formation in RCW 36 is currently ongoing. In the dense gas at the center, where the far-infrared emission is greatest, there are protostellar cores, Harbig Haro objects and an ultra-compact HII region. However, more deeply embedded star-formation is obscured by dust, so radiation can only escape from the cloud surface and not from the embedded objects themselves (Ellerbroek et al. 2013).

Petterson and Reipurth (1994) surveyed the Vela Molecular Ridge for Hα emission-line stars, finding 747 of them, ESO-Hα 2429 among them. Pettersson (2008) lists spectroscopically confirmed pre-main sequence stars and candidates in the region.

RCW 36 was surveyed (Armond, 2019) at the SOAR telescope using slitless spectroscopy and an Hα filter with the Goodman spectrograph, to search for emission-line stars, as part of a larger survey on star-forming regions.

3. ESO-Hα 2429

At the western edge of this region, a few arc-minutes away from the central cluster, one star caught our attention for having an unusually broad Hα emission line. Pettersson (2008) classify ESO-Hα 2429 with spectral type K2.

Long slit spectra were taken with the 600 l/mm grating and the 0.8" slit (yielding a dispersion of 0.64 A/pix and R=1900). The Hα line width was 25Å, indicating velocities of ~ 550 km/s.

In follow up observations, spectra were taken again on several dates spanning one year, using different gratings. On all occasions the width of the line was about the same (25Å). The profile was almost always double peaked, but the peaks did not have the same intensity. All line profiles are over-plotted in Figure 1.

At the first observations we suspected it was a binary system, but as the line width maintained the same over one year, we assume that we are seeing disk accretion at unusually high velocities. We do not know why, since the star is not associated with a known jet and it is relatively far from the more active star formation cluster.

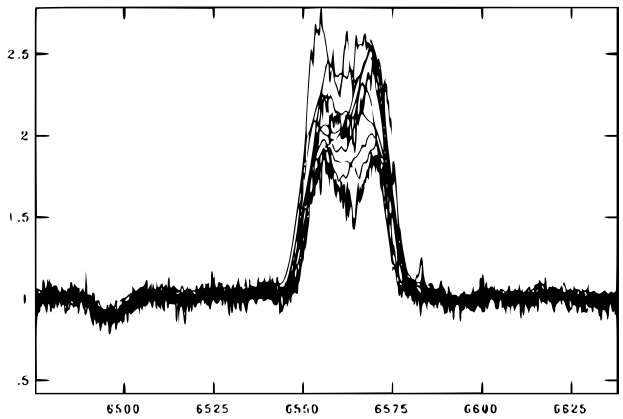

Figure 1: All emission lines overplot: average velocities at extremes approximately 550 km/s.

4. Conclusions

As part of a wider search for emission line young stars, we found an unusually wide Hα emission line that, although variable in profile, remained wider through one year of follow up observations. This work is still in progress. We are carrying out bibliographical research on the topic and analyzing the data available in virtual observatories. The hypotheses we raised is: the protostellar disk could be accreting or ejecting matter, at very high speed. The changes in the line profile could be an effect of rotation.

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