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YOUNG STELLAR OBJECTS IN GY 2-18 (IRAS 05439+3035)

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We present the results of optical and near-IR spectra and mid-infrared images of the star-forming region Gy 2-18, which is associated with IRAS 05439+3035.

Gy 2-18 is a peculiar nebulosity suspected to be an Herbig-Haro (HH) object (Gyulbudaghian 1983) embedded in a molecular cloud marked by CO ($J=$ 1–0) in emission (Wouterloot & Brand 1989). The *IRAS* source 05439+3035 is associated with this nebulosity, and its 1 to 100 μm spectral energy distribution (SED) is characteristic of a young stellar object (YSO; Persi et al. 1988). CCD images of Gy 2-18 revealed an optically visible star with strong Hα emission illuminating a faint reflection nebula. In addition, ten infrared sources with significant excess emission at $\lambda \geq 2\,\mu$m from *JHK* images were found by Tapia et al. (1997). Three of these (#9, #11, and #13) are within the *IRAS* positional ellipsoid. Source #11 coincides with the visible star.

The narrow-band images at 8.7, 9.7, and 12.5 μm of Gy 2-18 were taken on 2001 January 14 with the mid-infrared camera CID (Salas et al. 2003) at the 2.1 m telescope of the Observatorio Astronómico Nacional at San Pedro Mártir, B. C., Mexico (OAN-SPM). This camera is equipped with a Rockwell 128×128 pixel Si:As BIB detector array, and delivers an effective scale of $0\farcs55\,\mathrm{pix}^{-1}$. The mid-IR images and a 2.2 μm image of the region (shown for comparison) are displayed in Figure 1. Two point sources separated by $3\farcs8$ in R.A. and $0\farcs8$ in Dec. and surrounded by diffuse emission are present in all mid-IR images. These sources are IRS 9 and IRS 11, and they are marked in the 2.2 μm frame. The weakest of the two at 8.7 and 12.5 μm has been identified with IRS 11 and its visible counterpart. IRS 9 appears very red with a deep silicate band at 9.7 μm in absorption.

Optical and near-IR spectra of the visible star IRS 11 have been obtained in the 4000 to 9000 Å range with the Loiano 1.52 m telescope with the Bologna Faint Objects Spectrometer and Camera, and between 1.15 and 2.4 μm with the Infrared Camera/Spectrograph CAMILA (Cruz-González et al. 1994) mounted at the 2.1 m telescope at OAN-SPM.

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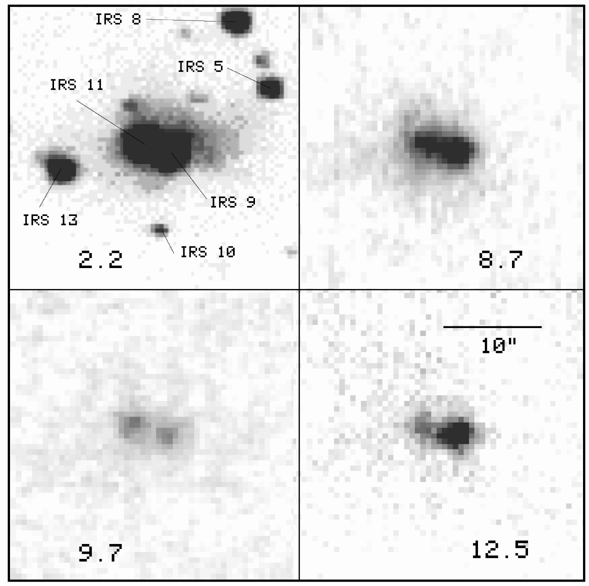

Fig. 1. Near- and mid-infrared images of Gy 2-18. The brightest near-IR sources in the field are indicated on the *K*-band image. The scale is shown by a horizontal bar. North is to the top and east to the left.

From the analysis of these spectra, we deduce that IRS 11 is a reddened ($A_V = 7.5$) early type star (B0–B2), probably a Herbig Be star illuminating a reflection nebula observed in the optical and near-IR. A stellar wind is associated with the star, and the mid-IR observations suggest the presence of a circumstellar dust disk. More deeply embedded in the cloud is IRS 9 ($A_V = 40$). The observed very steep energy distribution ($\alpha_{\mathrm{IR}} = 1.9$) indicates that this object is a massive protostar with $L_{\mathrm{BOL}} = 8.6 \times 10^3\, L_\odot$. Most of the *IRAS* far-IR flux comes from this YSO. We estimated the distance to the region to be ≤ 5.7 kpc. A detailed discussion of the observations of Gy 2-18 is given in Persi et al. (2002).

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