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Gas and Stellar Kinematics in NGC 6240

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Abstract. We present results from sub-arcsecond near infrared integral field spectroscopy and millimeter IRAM-interferometry of the interacting galaxy NGC 6240. Using stellar absorption features in the NIR we determined the stellar velocity field and dispersion in NGC 6240. The two NIR emission peaks show rapid rotation and indicate a prograde encounter of the two progenitor galaxies. From the velocity dispersion an excess mass between the two nuclei is detected. This mass can be attributed to a massive rotating disk of cold CO gas located between the nuclei.

1. Introduction

The luminous infrared galaxy (LIRG) NGC 6240 has a remarkable disturbed large scale morphology and two nuclei in the central region. It appears to be an interacting and merging system of two galaxies. NGC 6240 is a very luminous source of near-infrared H_2 line emission, most likely excited in shocks triggered by the collision of the two galaxies. NGC 6240 emits more than 90% of the bolometric luminosity $L_{bol} = L_{IR} = 6 \times 10^{11} L_{\odot}$ (for $H_0 = 75\,\mathrm{km\,s^{-1}Mpc^{-1}}$, $D = 97\,\mathrm{Mpc}$) in the infrared wavelength range. There is consensus that the infrared emission comes from warm dust but what is the primary energy source responsible for heating the dust is still a matter of debate. The two possibilities are a deeply dust embedded active galactic nucleus (AGN) or a super starburst.

2. Stellar Content

A comparison of the NGC 6240 spectrum with stellar template spectra shows that late K or early M supergiants dominate the K-band light of the two nuclei. The K-band luminosity of NGC 6240 can only be explained with a major starburst. The age of the supergiants constrains the age of the starburst to 15-25 million years. The Brγ equivalent width together with starburst models can be used to determine the starburst duration. In NGC 6240 the starburst was rather short, only 5 million years, and was most likely triggered by the last close encounter of the two galaxies. Negative feedback effects from stellar winds and supernovae explosion lead to episodic star formation in the nuclei of NGC 6240.

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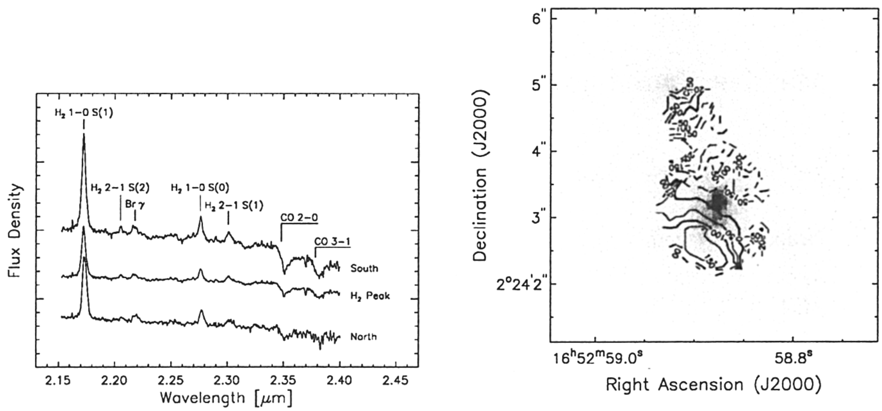

Figure 1. Selected spectra (left) and the stellar velocity field in $km\,s^{-1}$ (right) of NGC 6240

3. Gas and Stellar Dynamics

The CO $2-0$ absorption bandhead are investigated with a Fourier-Correlation technique as well as direct fitting techniques to derive the stellar dynamics of the two nuclei in NGC 6240. The stellar velocity field shows two rotating stellar disks with rotation velocities of $\approx 250\,km\,s^{-1}$ and equal dynamical masses of $2-8\times10^9\,M_\odot$. With such a high mass the nuclei can only be the bulges of the progenitor galaxies. Both disks have independent rotation vectors showing that the interaction is not yet in the final stage of merging. The stellar velocity dispersion is rather high with a maximum of $\approx 280\,km\,s^{-1}$ at a position between the two nuclei, indicating a dark mass concentration between them.

Millimeter interferometry in the CO $J=2\rightarrow1$ line shows that the cold molecular gas is concentrated between the two nuclei. The cold molecular gas forms a self-gravitating, rotating CO–disk with a total gas mass of $\approx 2\times10^9\,M_\odot$. Large line-widths of $\approx 500\,km\,s^{-1}$ indicate very turbulent gas motions which also explain the lack of star formation despite the huge gas mass in the nuclear region of NGC 6240. The hot molecular gas of NGC 6240 as seen in the $H_2\,1-0\,S(1)$ emission line shows the same morphology as the CO $J=2\rightarrow1$ line emission. It is through the near infrared H_2 line emission that the turbulence kinetic energy will be dissipated within the next 10 million years after which a major starburst can set in.

References

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