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IRAS 03158+4227 – a ULIRG in a Widely Separated Pair of Galaxies

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Abstract. We present new deep optical images, optical spectroscopy, and high-resolution NIR images of IRAS 03158+4227, one of the most luminous ULIRGs from the IRAS 2 Jy sample. The data are best explained either by a multiple merger or by the assumption of a ULIRG triggered in an early phase of galaxy interaction.

1. Introduction

Ultra-luminous infrared galaxies (ULIRGs) are an important class of extragalactic objects which are probably related to AGNs. The standard picture of activity in nuclear regions of galaxies invokes dissipative gas infall toward the centre induced by galaxy-galaxy interactions. It is claimed that the ULIRG phenomenon is triggered during the final stage of galaxy mergers. Although ULIRGs show in general strong evidence for tidal distortions, IRAS 03158+4227 has been described as an apparently single and undisturbed system (Murphy et al. 1996).

2. Observations and Discussion

We performed observations of IRAS 03158+4227 at the DSAZ[1], Calar Alto, Spain. Spectra and deep optical images (BRI bands and unfiltered, respectively) were taken with the 2.2 m-telescope equipped with CAFOS at a seeing of typically $1''$. High-resolution imaging in the JHK′ bands was performed using the adaptive optics system ALFA at the 3.5 m-telescope. In addition, wide field images were taken with the Tautenburg Schmidt CCD camera in the R and I band. Based on these new observations, IRAS 03158+4227 is found to be a member of a binary of two giant galaxies (G1 and G2, Fig. 1) with a projected nuclei separation of 47 kpc ($H_0 = 75\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$) and a radial velocity difference of less than about $200\,\mathrm{km\,s^{-1}}$. Strong emission lines are detected from the nuclear regions of both galaxies. There is no evidence for a double nucleus in the ULIRG's host G1 down to a separation of $0\farcs4$ (corresponding to about 1 kpc at the distance of the galaxy). The deep optical images (Fig. 1) clearly reveal that G2 has a faint but very extended material arm on the side opposite to G1. This structure is the most prominent peculiar morphological feature of the binary.

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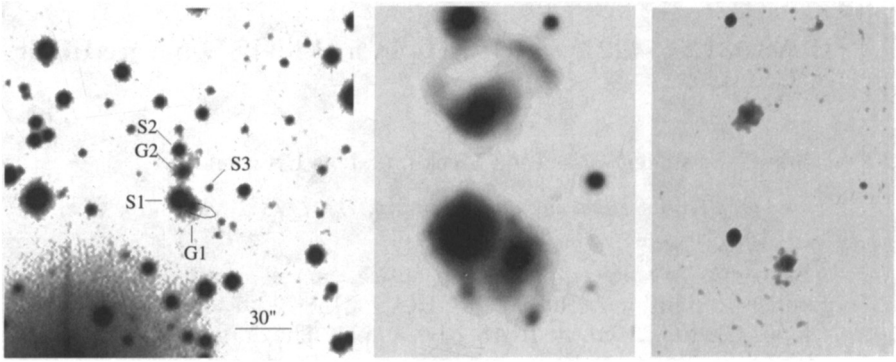

Figure 1. *Left:* the 3.′3 × 3.′3 field around the IRAS error ellipse of IRAS 03158+4227 (coadded R and I band images taken at a seeing of about 2″); G1 and G2 are galaxies, S1 to S3 stars. *Middle:* optical composite image (BRI bands plus unfiltered image) of the G1-G2 pair at a seeing of about 1″ after Lucy-Richardson deconvolution. *Right:* composite NIR image (JHK′ bands) taken with the adaptive optics system ALFA. The size of the field is 30″ × 42″, N is up, E is left.

3. Conclusions

The long, faint tail emanating from G2 indicates strong tidal forces. The results of numerical simulations admit the interpretation of this structure as due to tidal interaction with G1 (Meusinger et al. 2001). It is tempting to speculate that the activities in both galaxies were triggered by the same process, namely the gravitational interaction of G1 and G2. In this case, IRAS 03158+4227 has to be interpreted as an early stage of merger like IRAS 23327+2913 (Dinh-V-Trung et al. 2001). Alternatively, IRAS 03158+4227 may be the result of a multiple merger (e.g., Borne et al. 2000) in a compact group: even though we do not find evidence for a close double nucleus, the host G1 might be a merger in a very advanced stage with a projected nuclei separation of less than 1 kpc. Then, however, the huge star formation rate derived from the infrared-luminosity of IRAS 03158+4227 seems to be be surprising (cf. Bekki 2001).

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