

Is a Local Bar a Good Place to Find a Companion? The Near Infrared Morphology of Maffei 2

Robert L. Hurt (UCLA), K. Michael Merrill (NOAO),
Ian Gatley (NOAO), & Jean L. Turner (UCLA)

Maffei 2 is one of the closest large spiral galaxies lying just beyond the Local Group. It would probably be one of the most heavily studied galaxies in the sky were it not for the ~ 5 magnitudes of visual extinction resulting from its position behind the Galactic plane ($l = 137^\circ$, $b = -0^\circ.3$). It is the site of a burst of nuclear star formation indicated by strong infrared ($L_{\text{FIR}} \sim 4 \times 10^9 L_\odot$; Rickard & Harvey 1983; Ho *et al.* 1989), Brackett line (Ho, Beck, & Turner 1990) and radio continuum emission (Seaquist, Pfund, & Bignell 1976; Turner & Ho 1992). Interferometric maps of ^{12}CO (Ishiguro *et al.* 1989) and ^{13}CO (Hurt & Turner 1991) emission indicate that star formation is associated with a barlike structure consisting of arms of molecular gas that extend from within ~ 50 pc of the dynamical center out to a radius of at least 500 pc. HI maps have shown the galaxy to have an angular extent of $\sim 15'$ and a neutral gas mass typical of a large spiral galaxy (Bottinelli *et al.* 1971; Shostak & Weilachew 1971; Love 1972; Hurt, Turner & Ho 1992).

Near infrared imaging of Maffei 2 using the Simultaneous Quad Infrared Imaging Detector (SQIID) at KPNO has proven a successful tool in determining the morphology of this optically obscured galaxy. It is a barred spiral galaxy with two distinct arms and a bright nucleus which are clearly visible in the K-band (Fig. 1). We find its Revised Hubble type to be SBb(s) pec. Its classification of "peculiar" is warranted by its asymmetric stellar distribution. The eastern spiral arm is more diffuse and about twice as long as the western arm, and the NE and SW halves of the bar are misaligned by $\sim 10^\circ$ when viewed in deprojection. There is also an anomalous arm in the north that appears to lead the end of the NE bar.

The infrared extinction traced in the J-band (Fig. 2a) and more clearly in the J-K image (Fig. 2b) matches the known distribution of molecular gas in this region. Within the inner arcminute of the nucleus mapped in ^{13}CO (Fig. 2c; Hurt & Turner 1991), the correlation between the density profile of the molecular gas component and the variations in the J-K image are striking (Fig 2d). The near infrared extinction appears to be an excellent tracer of molecular gas.

The presence of the disrupted morphology and nuclear starburst in Maffei 2 argues for some form of recent tidal perturbation. The first obvious candidate would be its companion Maffei 1, though the large distance between them ($40'$; 60 kpc) makes a dynamically recent interaction unlikely. The other alternative is that there is a closer companion which has remained undiscovered because of the high extinction in this region. The best shot at finding such a companion, which could easily have been stripped of gas from previous tidal encounters, would be in the near infrared. Indeed, there is a potential candidate in the SQIID images. The compact object at the end of the anomalous northern arm (Fig. 1) could well be a dwarf companion in the process of tidally disrupting the galaxy. In this scenario, the anomalous arm might then represent a streamer of material tidally drawn out by the encounter.

- Bottinelli, L. *et al.* 1971, A&A, 12, 264
 Ho, P. T. P., Beck, S. C., & Turner, J. T. 1990, ApJ, 349, 57
 Ho, P. T. P., Turner, J. T., Fazio, G. G., & Willner, S. P. 1989, ApJ, 344, 135
 Hurt, R. L. & Turner, J. T. 1991, ApJ, 377, 434
 Hurt, R. L., Turner, J. T., & Ho, P., 1992, in preparation
 Ishiguro, M. *et al.* 1989, ApJ, 344, 763
 Love, R. 1972, Nature, 235, 53
 Rickard, L. J. & Harvey, P. M. 1983, ApJ, 268, L7
 Seaquist, E., Pfund, J., & Bignell, R. 1976, A&A, 48, 413
 Shostak, G. & Welachew, L. 1971, Ap. J., 169, L71
 Turner, J. L. & Ho, P. T. P. 1992, in preparation

Figure 1

K-band Image

The contrast in this image has been adjusted to enhance the low surface brightness structures. Visible in this image are the bar and arms. The SW bar and western arm are compact and better-defined than the more diffuse NE bar and eastern arm. The eastern arm is about twice as long as the western one and has an anomalous extension directly to the north. This extension could be a small companion in the process of interacting with Maffei 2. The box indicates the area covered by Figure 2 (below).

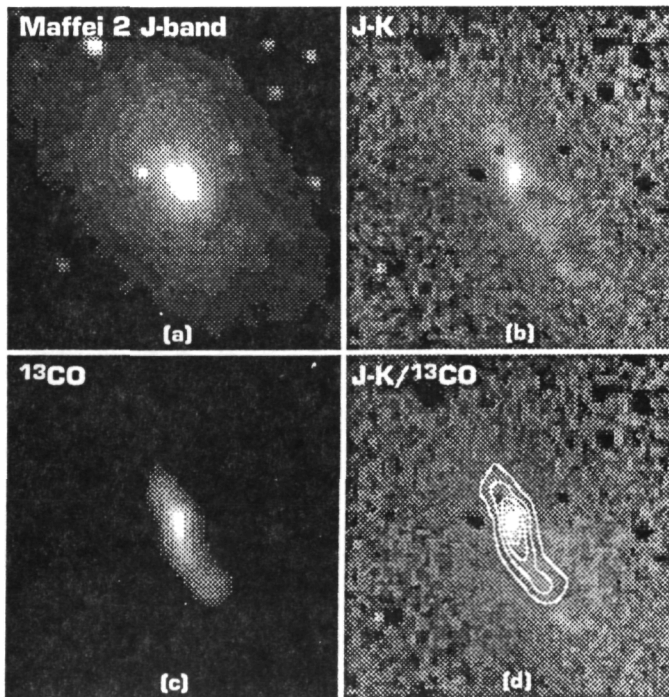
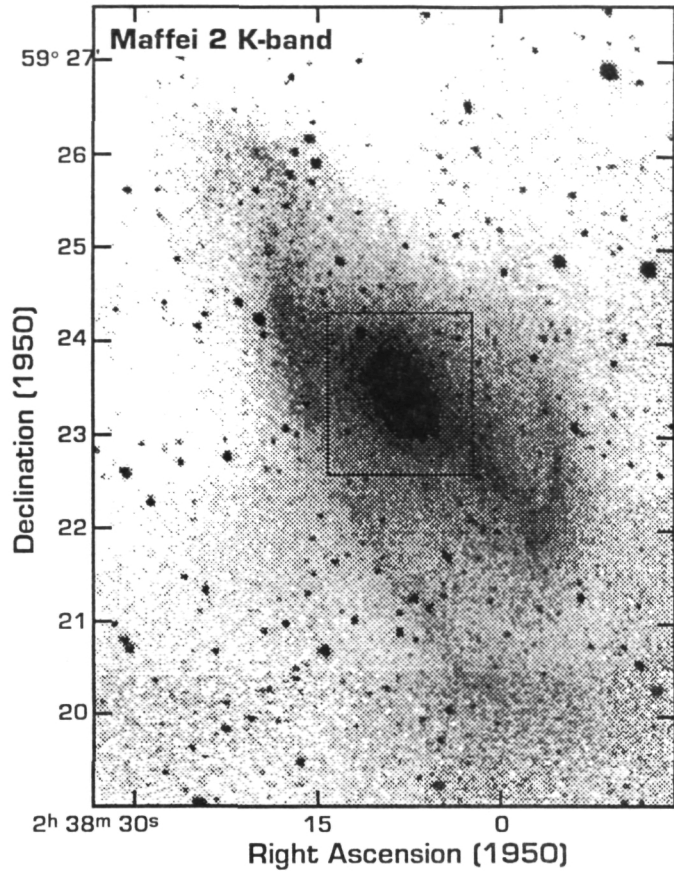


Figure 2

J-band, J-K, and ^{13}CO

Figures 2a-2d cover a $95'' \times 100''$ field, centered on the nucleus. Fig. 2a shows the J-band emission for this region, with clearly visible lanes of extinction. Fig. 2b is a J-K image constructed by taking a ratio of the individual J and K band images. The white to black greyscales represent ratios of 0.4 to 1.0. Fig. 2c is a greyscale representation of the ^{13}CO emission within a half-arcminute of the nucleus of the galaxy (Hurt & Turner 1991). The black to white greyscales represent integrated emission from 0.0 to 120 K km s^{-1} . Fig. 2d overlays contours of the ^{13}CO emission on the J-K map of Fig. 2b.