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THE NATURE OF THE COMPACT GROUP HCG 54

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We present here a study of HCG 54 based on deep optical images and spectroscopy, as well as high resolution H I data obtained with the VLA. HCG 54 is embedded in an H I cloud of diameter 12 kpc plus a 20 kpc tidal tail emerging from its western edge. The formation of this tail can be explained by the passage of a dwarf galaxy that we found close to the end of the tail. The central system is surrounded by several optical shells produced by the interaction of two disks. HCG 54a is probably the main object of the system, while HCG 54cd might constitute the remnent of the second merging body.

Interaction constitutes one of the main components contributing to galaxy evolution. In strong mergers there are easily recognized features such as plumes or tails. However, to detect features when the degree of interaction is lower, or at high redshift, or when measuring their extent and shape much deeper and more detailed observations are needed. Very large telescopes provide a long-awaited tool for approaching such studies since only with these will it be possible to observe the low density diffuse stellar component that traces almost uniquely the mass distribution and compare it with the different phases of the gas. Compact groups are examples of such targets; they have high densities and low velocity dispersion ($\sigma_V \sim 200$ km s^{-1}), so interaction is surely affecting the evolution of their galaxy members. The revised Hickson et al. (1992) catalogue contains 69 physical groups when chance projections are removed. However, the nature of a few groups is still under debate. For example, HCG 54 is proposed by Hickson et al. (1989) to be a small group composed of four dwarf late-type galaxies occupying the lower end in luminosity, velocity dispersion, and diameter. There is evidence that HCG 54 could be a single galaxy composed of several bright H II regions (Arkhipova et al. 1981; Verdes-Montenegro et al. 2001; Vílchez & Iglesias-Páramo 1998).

We obtained optical images and spectra with the 2.5 m Nordic Optical Telescope (NOT) on La Palma using the ALFOSC spectrograph. The photometry was obtained in B and R Johnson and r' Gunn filters with a total exposure time of 6000 s, 4800 s, and 7200 s respectively. In order to cover a large field tracing the H I tail direction a $16'.7 \times 16'.7$ mosaic was built combining ten R band exposures. A subset of the resulting field is shown in Figure 1, where two previously unclassified galaxies (A1127+2054 and A1127+2057) are marked. There are no galaxies with measured redshift at the same velocity as the group within a volume of radius of 0.5 Mpc. Our spectra show that the northern galaxy (A1127+2057) is a background object with $z = 0.052$. The only clearly identified companion in the area of the group is the dwarf galaxy A1127+2054, which we detect in H I.

Individual spectra were extracted for a total of nine zones, six along the slit position along the ab knots and three along cd. HCG 54a shows strong Balmer absorption lines over the continuum, characteristic of post-starburst population. All the other spectra show typical H II region features. HCG 54b shows high excitation and Wolf–Rayet features over a flat continuum, indicative of a young and strong burst of star formation. All selected zones are consistent with 12+logO/H$\sim$8.3; this abundance is typical of the Large Magellanic Cloud and of the outer regions of late-type spirals.

Radial velocity curves were obtained in the directions joining HCG 54a and b and HCG 54c-d, showing perturbed kinematics. HCG 54a shows a distorted rotation curve with an amplitude of $\sim$45 km s^{-1}. Regions with a completely different velocity (about 100 km s^{-1}) overlap with the main trend and might correspond to two systems.

We mapped the group with the VLA in C array with a synthesized $20'' \times 16''$beam and a velocity resolution of 10.4 km s^{-1}. We detected emission above 3σ in the velocity range 1334.2–1490 km s^{-1}. The total H I line flux is 6.23 Jy km s^{-1}, corresponding to an H I mass of 5.6×10^8 $M_\odot$. The H I emission is shown in Figure 1 as contours superposed on the R band mosaic. There a tail of emission about 20 kpc long which emerges to the NE with 10^8 $M_\odot$. At the end the tidal tail a knot of H I emission is associated

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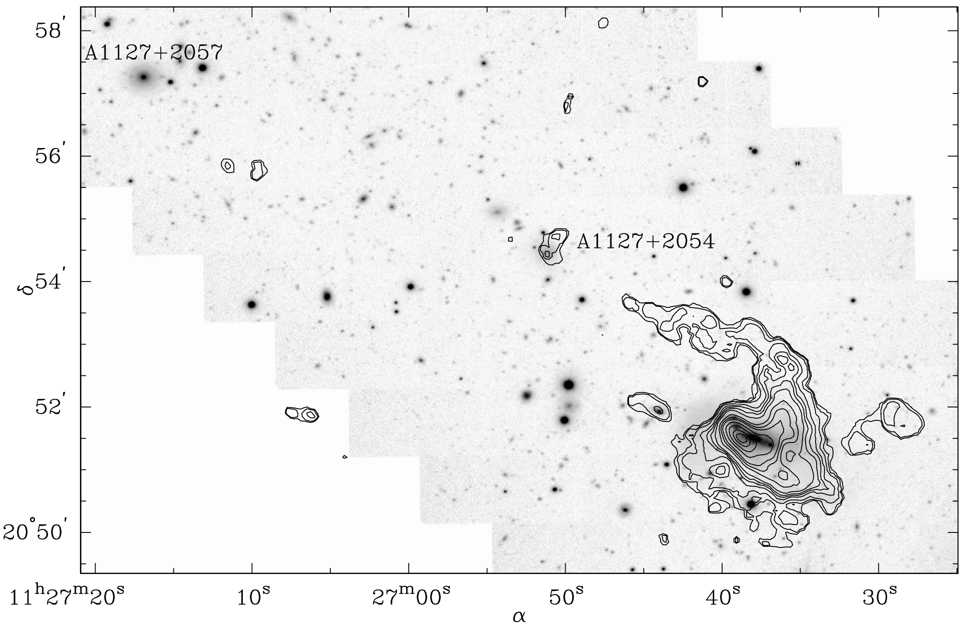

Fig. 1. HCG 54 H I integrated emission contours superposed on a R band mosaic.

with a small galaxy (A1127+2054), which is a slow disk rotator (~30 km s^{-1}) and $1.9{\times}10^7$ $M_\odot$ of H I. The galaxy has an absolute R magnitude of -14.2, a size of 2.6 kpc, and has an exponential profile.

Our optical images show the presence of several optical ripples around the brightest knots. Different scenarios can explain shell formation depending on the conditions of the parent galaxies. For HCG 54, the most suitable model corresponds to a merger of two equal-mass disks (Hernquist & Spergel, 1992). Although the existence of two objects is clearly inferred from the shell system, the identification of the interacting disks is not straightforward owing to the advanced stage of merging. The kinematics, as well as spectroscopic characteristics point to HCG 54a as one of the interacting systems. HCG 54 c and d might constitute the remanent of the second galaxy since their colors, kinematics, and excitation conditions are different from those of HGC 54a.

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