CG J1720-67.8: Radio and Integral Field Optical Observations

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Abstract. Our previous studies of the ultracompact galaxy group CG J1720-67.8 have revealed properties, which suggest that the group is in a very advanced evolutionary state. We present here new observations in the radio and optical regimes, which have been obtained in order to further investigate the dynamical and evolutionary state of the group. Velocity fields reconstructed from integral field spectra of two regions of the group, obtained with SPIRAL at the Anglo-Australian Telescope (AAT), show some degree of distortion and a considerable velocity gradient across one of the TDG candidates. Estimates of the HI content and of the overall star formation rate of the group are obtained from radio observations with the Australia Telescope Compact Array (ATCA) in the 21 cm line and in the 20 cm continuum.

Keywords: galaxy groups: individual (CG J1720-67.8), galaxies: interactions, galaxies: star formation

1. Introduction

CG J1720-67.8 (z = 0.045) is an ultracompact galaxy group (Weinberger, Temporin, & Kerber, 1999), whose members have a median projected separation of 6.9 kpc (H₀ = 75 km s⁻¹ Mpc⁻¹), a line-of-sight velocity dispersion of \( \sim 65 \) km s⁻¹, and show strong signs of mutual interactions. Our previous studies (Temporin et al., 2003; Temporin et al., 2002; Temporin & Fritze-von Alvensleben, 2002) suggest that this group is very evolved and therefore it offers us the rare chance to study the final evolutionary phases of compact groups (CGs). We give below a brief description of the group’s components, which are labeled in Fig. 1 (top-left) onto a R-band image obtained at the ESO 3.6 m telescope.

Galaxy 1: A blue (B−V = 0.47) starburst galaxy with an exponential bulge and a bulge-to-total light ratio B/T \( \sim 0.4 \), whose general properties are consistent with an Sc type. Since no spiral arms are visible, the galaxy could have lost its outermost layers in the interaction. A bridge of matter apparently connects this galaxy to galaxy 2.

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Galaxy 2: An S0 galaxy (B−V = 0.88) with a de Vaucouleurs bulge, which dominates its light (B/T ∼ 0.7), and traces of central star formation. Evolutionary synthesis models (Temporin & Fritze-von Alvensleben, 2002) suggest that this galaxy might be the result of a ∼ 1 Gyr old merger.

Galaxy 4: A disk dominated (B/T ∼ 0.2), moderately blue (B−V = 0.55), starburst galaxy with an exponential bulge. No obvious spiral arms are visible, but the galaxy shows internal structures, is in close interaction with galaxy 2, and appears connected to object 3+9, at the base of an outstanding tidal structure (“arc”).

Objects 3+9 and 7(+8): These objects are actively starforming, blue condensations (B−V ∼ 0.3), a few kpc in size, located at the opposite tips of the group’s tidal arc. They are promising tidal dwarf galaxy (TDG) candidates (Temporin et al., 2002).

Objects 10 and 12: These are moderately blue, less concentrated structures located in the central part of the tidal arc. Star formation activity is spectroscopically confirmed for object 10. These could be complexes of giant H II regions or TDGs in the process of formation.

Object 11: This knot is embedded in a ring-like structure in the group’s optical halo. Is it maybe a vestige of a faded tail formed in the merging process of galaxy 2?

2. Dynamics and Kinematics: AAT-SPIRAL Observations

Integral field spectra in the range 650 - 710 nm have been obtained in June 2002 at the AAT with SPIRAL for two $9''.8 \times 10''.5$ regions with the $14 \times 15$ microlens array positioned as in Fig. 1, top-left panel. Each lens imaged $0''.7 \times 0''.7$ of the source. The images, reconstructed by integrating the flux between 680 and 690 nm (Hα+continuum), are shown in Fig. 1 (top and bottom central panels) after magnification and projection onto a $60 \times 56$ pixel grid. The bridges of matter connecting galaxies 1, 2, and 4 are evident. Radial velocities were measured in every spectrum, where the Hα emission line was detected. The reconstructed velocity fields are shown in Fig. 1 (right-hand panels). Galaxy 1 shows a distorted velocity pattern, although the observed velocity gradient across the galaxy is very small (∼ 50 km s$^{-1}$). Galaxy 2, with a velocity gradient of ∼ 120 km s$^{-1}$ in NE-SW direction, shows a counter-rotation with respect to galaxy 1. The bridge of ionized gas between the two galaxies shows an intermediate radial velocity, as expected in case of a flow of matter. A considerable velocity gradient (∼ 200 km s$^{-1}$) is found across the TDG candidate 3+9. Such a gradient, especially at the location of this object, i.e. at the base of the tidal tail, could be
a consequence of projection effects or streaming motion along the tail, but it could also indicate the presence of a rotational motion.

A complete coverage of the group with integral field spectroscopy is still needed for a complete view of the complicated group dynamics.

![Figure 1. Top: The members of CG J1720-67.8 are labeled on a R-band image from the ESO 3.6 m telescope. Two boxes indicate the two positions of the SPIRAL array. In the central and right-hand panels the reconstructed Hα+continuum map and velocity field of galaxies 1 and 2 are shown after magnification and projection onto a 60×56 pixel grid. Bottom-left: Array of integral field spectra of galaxies 1 and 2. Bottom-center and right: Reconstructed, magnified, Hα+continuum map and velocity field of the TDG-candidate 3+9.](image)

3. Evolutionary State: HI Content of the Group

The galaxy group, previously undetected in the radio regime, has been observed with ATCA in January and February 2002 in the two configurations 750A and 1.5A at the central frequency 1360 MHz with a bandwidth of 8 MHz. After 2×12 hours synthesis (synthesized beam fwhm ~ 20"") the group still remained undetected in the 21 cm line. This gives an upper limit to the integrated HI mass of a few $10^9 \, M_\odot$, which suggests that the group is HI-deficient, consistent with it being in an advanced evolutionary state (Verdes-Montenegro et al., 2001).
Instead an extended source with a deconvolved size of \( 15''.6 \times 9''.2 \) and an integrated flux of 3.6 mJy, centered on galaxy 4, was detected in the 20 cm continuum. A high resolution map (beam fwhm \( \sim 6'' \)) was obtained by combining the wide-band continuum data with the two ATCA configurations and including data from the 6 km antenna. The result, overlapped with the optical image of the group, is shown in Fig. 2. The radio emission approximately follows the optical morphology of the group and has a secondary peak in correspondence of object 7, one of the most promising TDG candidates. Following Haarsma et al. (2000) we derived an overall star formation rate of \( \sim 17 \, M_\odot \, yr^{-1} \).

The new data presented here provide further confirmation of the advanced evolutionary state of CG J1720-67.8 and give additional evidence of the dynamical complexity of this strongly interacting system.

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