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The Nature of Hickson Compact Group 18

Henri Plana[1]

Observatorio Astronomico Nacional UNAM, Ensenada, Mexico

Claudia Mendes de Oliveira

Instituto Astronômico e Geofísico (IAG/USP), São Paulo, Brazil

Philippe Amram

Observatoire de Marseille, Marseille, France

Chantal Balkowski

Observatoire de Paris Meudon, Paris, France

Abstract. We present new observations of $H\alpha$ emission of the Hickson Compact Group 18 (HCG 18) obtained with a scanning Fabry-Perot interferometer. The velocity field does not show motions of individual group members but instead a complex common velocity field of H18b, c and d. The gas distribution is very clumpy with blobs coinciding with group members but located also elsewhere. Comparing $H\alpha$ with H I data we reached the conclusion that HCG 18 seems to be an irregular galaxy containing several clumps of star formation sites.

1. Introduction

HCG 18 (H18, Arp 258 or VV 143) has been catalogued by Hickson (1982) as an association of three irregular galaxies (H18b, c and d) and an SO galaxy (H18a), but it appears that the member a is a background galaxy with a redshift of 10000 $\mathrm{km\,s^{-1}}$ while the three others have redshifts between 4080 $\mathrm{km\,s^{-1}}$ and 4163 $\mathrm{km\,s^{-1}}$. The group shows H I neutral hydrogen emission (Williams and van Gorkom 1988) and FIR emission (Verdes-Montenegro et al 1998).

2. Observations

We observed the H18 group with a scanning Perot Fabry in the Hα emission line at CFHT and we obtained velocity and monochromatic maps. This observation is part of a larger program that has the goal of determining the dynamical stages of compact groups (see Mendes de Oliveira, this volume).

[1]Observatoire de Marseille, Marseille, France

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3. Results

3.1. Channel map

The interferograms of H18 show that the velocity amplidude of the Hα emission is small. The range of maximum emission is between 4068 and 4156 km s^{-1}. In this interval of velocities we can see that the emission is not located in a unique cloud but there are several spots. It also shows the connection between H18b and H18d.

3.2. Monochromatic emission

The monochromatic map shows an extension of 2.2' by 30". We calculated a total flux of 2.5×10^{-12} erg s^{-1} cm^{-2} and we derived an ionized gas mass of $M_{HII} = 2 \times 10^6\ M_{\odot}$. We found five bright emission regions, three matched to the group members b, c and d, and two others also have optical counterparts. A general view is that HCG 18 has a very clumpy morphology.

3.3. Velocity Field and velocity curves

The total extension of the velocity map is around 2.2' by 30". The radial velocity across the map varies from 4007 km s^{-1}, in the southern region to 4127 km s^{-1}, in the north and northeastern region. At first glance, the map shows that no obvious general motion is visible but also that no individual motions at the scale of the galaxy members are present. Nevertheless the southern region seems to have independent kinematics compared to the rest of the group.

Using the velocity field (VF) we have built line of sight velocity curves (LOSFC) (not corrected for inclination). In the south we found a disk-like rotation with a PA$=$ 80° showing a velocity amplitude of $\pm$ 60 km s^{-1}. The extension is around $\pm$ 25 arcsec. No members of the group (as catalogued by Hickson) are present but the continuum map shows the presence of a stellar component. This velocity gradient seems to show an independent motion of all the southern part of the group even if no consistent galaxy individual motion is seen. Along a PA$=$ 160° we found a velocity gradient from the north west to the south east with a mean value of $\pm$ 78 km s^{-1} over 90 arcsec. Member b is not exactly aligned along the axis with a PA$=$ 160°.

4. Comparison between H I and Hα data

Williams and Van Gorkom (1988) observed HCG 18 in the neutral hydrogen emission line. They give a velocity field and monochromatic image in H I of the group. They considered HCG 18 as a single giant cloud of 3'.0 $\times$ 2.5' where H I is not clearly associated with any of the group members b, c or d. They found a general rotation feature with a position angle of 20° and velocities which lie between 3990 km s^{-1} and 4140 km s^{-1}. We can also notice that the H I velocity field shows a variation of the PA along the major axis of the VF. In order to compare their data with the ionized gas kinematics, we performed a gaussian smoothing with a FWHM of 22" of our data cube. Fig. 1 shows the resulting velocity field. We also superimposed the H I velocity field from Williams and van Gorkom (1988). The ionized gas velocity field is less extended than H I.

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The velocity range is between 4000 $\mathrm{km\,s^{-1}}$ and 4170 $\mathrm{km\,s^{-1}}$ which is consistent with the H I velocity range (we found a displacement of < 10 $\mathrm{km\,s^{-1}}$). The morphologies of the velocity fields are different. The global aspect of the Hα VF is not as regular as the H I VF. The Hα VF shows a region of low velocities in the east of H18d where H I velocities are lower and it is difficult to see a consistent rotation. In the south both VF seem to be quite similar. In the north, the situation is less clear, it seems that the major axis of the Hα VF is close to 0° (except at the extreme north where it is close to 20°). If we look carefully, the PA of the isovelocities of the H I VF varies from 40° in the south, to 20° in the center and in the northeast. For our Hα VF, the variation is from around 20° in the south to 0° in the center. But due the presence of this "second component" on the west, it is difficult to say what the PA really is. A cross section of the VF along an axis with a PA = 20° shows a velocity amplitude of $\pm$ 50 km $\mathrm{s^{-1}}$ but the rotation is obviously not axisymetric.

5. Star formation history of HCG 18

Using our Hα data, literature data in the B band (Hickson 1993) and FIR (Verdes-Montenegro et al. 1998), we derived integral properties for the group. The ratios M(H I)/M(H II)= 5000, M(H I)/L_B = 0.9 and L_B/L(Hα)= 50. Using Sage et al. 1992 formulae we calculate Star Formation Rates from B, Hα and FIR luminosities, we found SFR(B)= 0.32 $M_\odot\,\mathrm{yr^{-1}}$ and SFR(Hα)= 6.1 $M_\odot\,\mathrm{yr^{-1}}$. We adopt the distance of 54 Mpc given by Williams and van Gorkom 1988. For the FIR component we found a ratio L(FIR)/L_B = 0.45 and L(FIR)/L(Hα)= 23.

6. Discussion — The nature of HCG 18

The main question that we would like to address about HCG 18 is its nature. Williams and van Gorkom (1988), with the H I data, raised this question asking if H I was an intergalactic cloud or really part of HCG 18. The main argument to consider that the H I component is an intergalactic cloud is given by the kinematics. The H I kinematics shows a systematic motion along an axis with a PA = 20° and not along the major axis of the disks of the group members. This suggests that the H I is not gravitationally bound to the galaxies. The smooth aspect of the H I VF indicates that the H I cloud may already be relaxed. On the other hand, the general aspect of the group itself is that of an irregular galaxy. The group is not clearly resolved into distinct galaxies and there are no precise centers. There are clumps of luminous material. The large amount of H I gas is consistent with that in other irregular galaxies such as IC 10 (Shostak and Skillman 1989) and NGC 4449 (Hunter et al. 1998). The slow rotation of the neutral gas ($\pm$ 100 $\mathrm{km\,s^{-1}}$) and the slow rotation gradient of 10 $\mathrm{km\,s^{-1}\,kpc^{-1}}$ is also consistent with what is found in irregular galaxies (Gallagher and Hunter 1984). Our study shows that the ionized gas kinematics has a rotation along the major axis of the group ($\sim$ 160°) even if the VF is not smooth in comparison with H I. This would be in favour of the irregular galaxy scenario, because it shows that group members are part of the gas rotation and part of a giant irregular galaxy. The ratio of L(B)/L(Hα) we found for H18 is consistent with the ratio found for other irregular galaxies (Hunter and Gallagher 1986 and Hunter et al

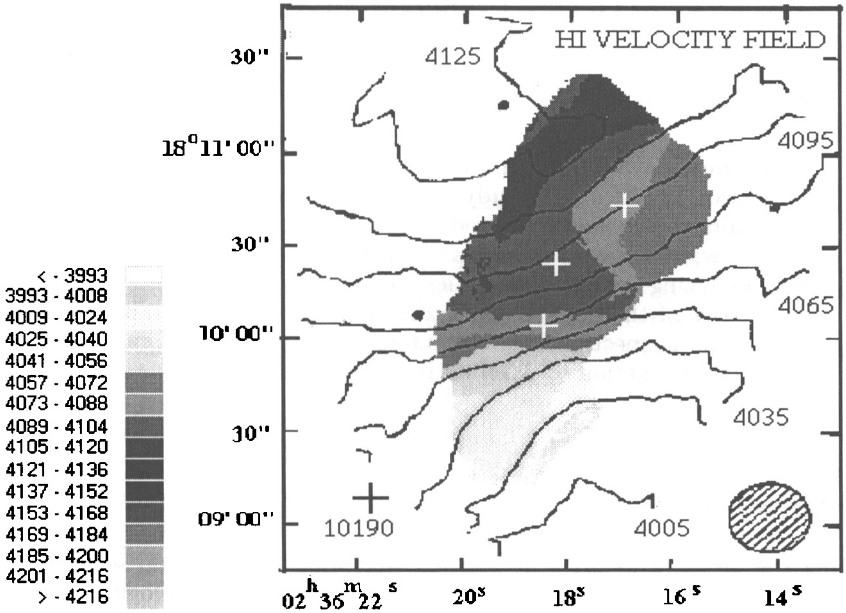

Figure 1. Velocity map of Hα line superimposed on the H I velocity field

1989). The FIR properties, however seem to be too low in comparison with other irregular galaxies. One point against the scenario of an irregular galaxy is the presence, in the south, of a part with a disk-like rotation apparently independent from the rest of the group. This rotation is not present when we smoothed the VF to be consistent with the H I VF, but it is clearly seen on the full optical resolution VF.

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