HIGH VELOCITIES IN THE INTERSTELLAR COMPLEX OF M17 (NGC 6618)

New Observations and Possible Mechanisms

J. MEABURN and J. R. WALSH
Dept. of Astronomy, University of Manchester, England

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Abstract. High-velocity features over a velocity range of 180 km s\(^{-1}\) have now been definitely identified on the profiles of the H\(\alpha\) line from the H\(\Pi\) region M17. A photon-counting image tube on the intermediate grating spectrograph of the 3.9 m Anglo-Australian telescope was employed.

Many mechanisms for the formation of these high-velocity phenomena and the co-moving H\(\text{I}\), molecular/H\(\Pi\) large-scale sheets, which have lower velocities, are considered.

Flows from ionization fronts moving into (and in one case breaking out from) small globules and large neutral sheets are compared to the large- and small-scale effects of energetic stellar winds.

External and internal supernova remnants are also discussed and radiation pressure on embedded dust grains and the ionized gas is not discounted. Motions generated during periods of star formation are also mentioned.

1. Introduction

The complex internal motions within the H\(\Pi\) region M17 (NGC 6618) were first found by Gershberg and Shcheglov (1964) and Meaburn (1971) and investigated in detail by Elliott and Meaburn (1975) and Elliott et al. (1978). Many large sheets of ionized material were identified, each with a distinctly separate heliocentric radial velocity \(V_{\text{HEL}}\) within a range of \(-60\) km s\(^{-1}\) to \(+25\) km s\(^{-1}\).

The largest number of velocity components over the largest range of \(V_{\text{HEL}}\) are found in line profiles over clouds of neutral hydrogen, dust and molecules which appear as dark areas on photographs. Moreover, the most negative components (\(V_{\text{HEL}} = -60\) km s\(^{-1}\)) are always the faintest and, consequently, have been always uncertainly detected. The brightest profiles from the vicinity of 'bright rims' are single and are on the mean \(V_{\text{HEL}}(\bar{V}_{\text{HEL}} = +9\) km s\(^{-1}\)) of M17. Goudis and Meaburn (1976) compared the values of \(V_{\text{HEL}}\) of the ionized material with those of the neutral hydrogen and molecules within M17 and found a close association of separate velocity components in complex [O III] (5007 Å) profiles with those in \(^{12}\text{C}^{16}\text{O}\) (ems) profiles from the same lines of sight. This suggested (Meaburn, 1977 and 1978) that M17, and other H\(\Pi\) regions, are composed of co-moving ionized and neutral sheets situated on the edge of much larger neutral clouds (Israel, 1978). Flows from ionization fronts were completely discounted as the dominant cause of these large-scale motions.

In the profiles of the H\(\alpha\) (6563 Å) line, observations of faint components which have the extreme values of \(V_{\text{HEL}}\) with respect to \(\bar{V}_{\text{HEL}}\) of M17 have now
been made (i) to confirm their reality, (ii) to establish the linear scale over which they are occurring within M17 and (iii) to derive accurate coordinates for these.

2. Experimental

The profiles of the H$\alpha$ (6563 Å) and [N II] (6584 Å) emission lines were observed over M17 with the intermediate dispersion spectrograph at 10 Å mm$^{-1}$ combined with the f/7.9 focus of the 3.9 m Anglo-Australian telescope. The slit width was 30 μm. The image photon-counting system (IPCS) (Boksenberg and Burgess, 1973) was the detector and, in its full two-dimensional mode, had 120 data-taking windows (each = 1.3′ long) placed over a long slit of total length = 162′ on the sky. The profiles from every four adjacent data-taking windows along the slit length were co-added and for each slit position separate profiles from 30 elements, each 5.3′ long, were produced for each emission line.

The spectra were calibrated against that from a Cu–Ar lamp and the absolute heliocentric radial velocities (V$_{HEL}$) quoted here are generally accurate to ±3 km s$^{-1}$. The measured instrumental halfwidth was 23 km s$^{-1}$.

The slit was positioned to an accuracy of ±2′, and this was recorded with a polaroid camera.

3. Results

The positions A to E of the E–W slit are shown in Figure 1 against part of the excellent [S II] photograph of T. R. Gull in Figure 2. These positions are over the obvious obscuring clouds in this area of M17.

In Figure 3 the wings of several H$\alpha$ profiles are shown, where high-velocity components are present. The maximum number of counts in one channel at the peak of each profile is also given. The trends in V$_{HEL}$ for individual velocity components along the slit lengths are given in Figures 4(a) to 4(e). As H$\alpha$ is ~7 times brighter than [N II] the very faint components with highest velocities (circled dots and wings W) are from these profiles, whereas the thermal broadening of [N II] is ~4 times less than for H$\alpha$ and, consequently, the lower velocity but brighter components (crosses) are more easily identified in the [N II] profiles. However, many blended components within a range of ±10 km s$^{-1}$ of the mean heliocentric radial velocity $\bar{V}_{HEL}$ are not clearly identified in the present work as a consequence of the low-velocity resolution (~23 km s$^{-1}$), but can be seen in the previous results of Elliott et al. (1978) obtained with a velocity resolution =6 km s$^{-1}$ (although lower spatial resolution). Only certainly identified (~3 noise level) high-velocity components are included in Figure 4. The value of $\bar{V}_{HEL}$ from bright single [O III] profiles (+7.5 km s$^{-1}$) and molecular measurements (+7 km s$^{-1}$) (Goudis and Meaburn, 1976) is also indicated. The linear scale in Figure 4 is based on a distance of 2.1 kpc to M17 which is the mean of widely