The Scientific Merit of Amateur Astrophotography

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Astrophotography is only a small fraction of the broad spectrum of amateur astronomers' work. With the development of high-sensitivity emulsions, amateur telescopes of large focal ratios and good quality, cheap multi-purpose cameras (both 35- and 70-mm), and intensive public relations work done by observatories as well as by individual, advanced amateurs, the methods and techniques of astrophotography have become accessible to all amateurs. With suitable equipment, experience, and familiarity with astronomical problems (e.g. by close contact with professional astronomers), they are even able to make valuable contributions to science.

But, unlike other fields of work (e.g. the determination of light-curves of variable stars), the scientific content of photographic images obtained by amateurs can only be extracted by using rather tricky and complicated methods, which are rarely accessible to amateurs. An important additional condition is therefore that professional astronomers be open-minded about serious work by amateurs, and also willing to support it.

Photography with cameras having large fields of view ($> 5°$) can be considered as supplementing work with professional Schmidt telescopes. Both types of instrument show similar sensitivity to low surface-brightness, found in very extended objects. Up to 25–25 mag/(arcsec)^2 can be detected by normal wide-field cameras if suitable equipment (emulsions, and photographic filters) is used. This applies to extended objects like the zodiacal light, bright comets, gaseous nebulae and dark clouds. For point sources like asteroids or variable stars, on the other hand, amateurs only have the advantage of greater observation time over professionals.

We will give two examples of cooperation between amateurs and professionals. The first one is the faint and very extended emission nebula S 27 ($> 13°$ around the central star ζ Oph (spectral type O9.5V). Figure 1 shows a wide-field image of the nebula obtained by an amateur using a normal 35-m camera, 103e-E film and a glass RG 645 filter. The exposure time was 105 minutes. The original negative film was digitized and the background, which varies over the image because of vignetting and the increasing stellar density towards the galactic equator, was subtracted. Finally the wide-field image of the nebula could be intensity calibrated in absolute physical units (cf. Celnik, Weiland, 1987). Such results can also be used for comparison with observations in other wavelengths (UV, radio), for example to determine the physical conditions within the nebula or to find out its true three-dimensional structure.

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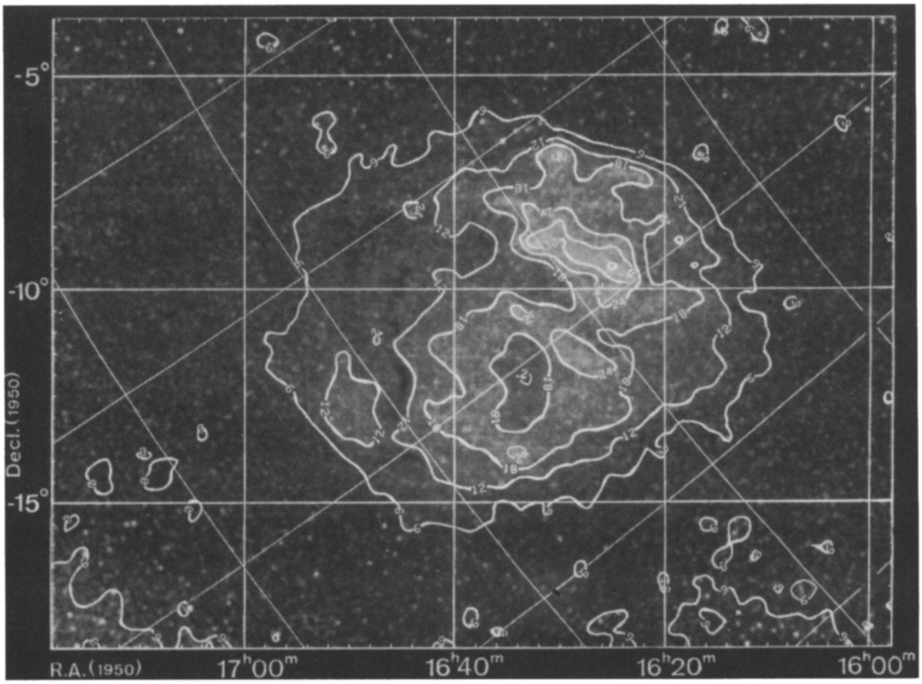

Fig. 1. H-α emission-line intensity map of the H II region S 27. The numbered isophotes indicate the density in units of 6.67×10^{-7} erg cm^{-2} s^{-1}sterad^{-1}.

Fig. 2. Plasma tail of Comet P/Halley on 1986 March 9, 07:59 UT. A camera with a 760-mm, f/4 lens was used with Kodak 103a-F (hypered), and a filter centred on 426 nm (CO+)

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The second example is Comet P/Halley, which was observed with wide-field cameras ($\sim 30^\circ$ in different spectral wavelengths. Figure 2 shows the structured plasma tail of the comet. Plasma clouds with striking structure are streaming away from the coma and can be followed by photographing them hour by hour or day by day. Using quite simple mathematics, velocities (up to 300 km/s), acceleration (about $32\,m/s^2$), the time of zero distance from the nucleus (ejection time), and the initial velocity of each observable cloud could be obtained from many original images. In this connection the detection of faint plasma clouds far from the nucleus was very important. The distribution of ejection events in time leads to a sidereal rotation period of 50.5 ± 0.6 hrs and to the distribution of outburst sources over the surface (Fig. 3), showing two main sources at the long ends of the ellipsoidal nucleus (cf. Celnik, Schmidt-Kaler, 1987).

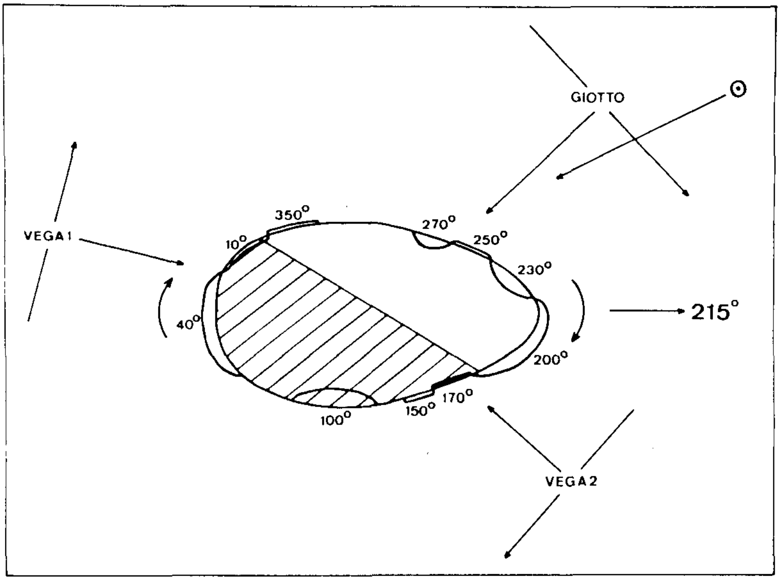

Fig. 3. Distribution of outburst sources along the equator of the rotating nucleus of P/Halley. Strong sources occur at the long ends of the nucleus. The views from different space probes during their respective fly-by encounters are indicated. The shaded area indicate the shadowed region during the GIOTTO fly-by.

The conclusion must be that amateurs are not only able to produce "nice pictures" but also that astronomical science can profit from systematic work by serious amateur astrophotographers. On the other hand this can only be successful if both amateurs and professionals are willing to cooperate.

References

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