on the average and may be the equilibrium ratio in the case of continuous star formation. The high ratio found in NGC 604 might then be interpreted as the appearance of a stellar population which has been formed in a single burst about 4×10^6 years ago.

If these high number ratios of Wolf-Rayet stars are found to be common in giant H II regions, they will have large implications on our knowledge of both the WR phenomenon and the star formation and stellar evolution in giant H II regions in external galaxies.

Spinning Asteroids and Photometry: A View of a Modern Topic

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Introduction

When I first applied for telescope time at ESO in 1976 to carry out photometry of asteroids, I had no idea about the impact of such a programme. As a matter of fact, photometry of asteroids is a method to study those objects in detail for their physical properties such as rotation rates, diameters, surface properties, albedo, geometrical configurations, orientation of rotational axis in space, even masses and densities.

In the meantime quite a number of active asteroid observers have joined and a close cooperation started a few years ago; groups at Torino (F. Scaltriti, V. Zappalà), Brussels (H. Debehogne), Liège (A. and J. Surdej, formerly at ESO), Uppsala (C. I. Lagerkvist) and myself at Graz contributed to the success of the observations of minor planets. Still, the center for collecting all data of asteroids is Tucson-Lunar and Planetary Laboratory, where the TRIAD-file (Tucson Revised Index of Asteroid Data) is maintained, and updated. Though there are many different methods to obtain physical data of asteroids, including infrared, polarimetry or spectrophotometry, I restricted myself to conventional photometry with the main goal to obtain rotation rates, lightcurves and UBV data for an individual asteroid.

Rotation Rates

Times when we considered an asteroid only as a moving pointlike source of light are over. We use ephemerides of course to find and identify objects (you should try to identify a faint asteroid at the beginning of a night on the telescope, if near the Milky Way) and later on, orbital parameters for statistical reasons. If successful in finding the asteroid to be observed (sometimes a few of them in a single night), we follow the object like doing photometry of a variable star, but considering that the object is moving; sometimes fainter stars are included in the diaphragm and those data have to be eliminated, sometimes reidentification in different nights is more difficult.

After successful observations we hopefully obtain an accurate period of rotation of the asteroid body; periods range from only $2^h.27$ (1566 Icarus) and up to $80^h.00$ (182 Elsa). The distribution of rotation periods roughly peaks between 5^h-11^h, but nobody really knows if those periods are generally preferred in the solar system, or if this is caused only by a selection effect.

In Fig. 1 the enormous increase of our knowledge of asteroid rotational data in the last years is shown, leading now to a good data material for statistical analysis. From the histogram of rotation periods we may obtain the following facts:

(a) although the number of observed asteroids has increased by a factor 5 since 1975, still the major part rotates with a $5-11^h$ period.

(b) long periods (slowly spinning objects) show up due to observations carried out carefully or with more patience: 654 Zelinda $31^h.9$ (1975) 393 Lampetia $38^h.7$ and 128 Nemesis $39^h.0$ (1979), 709 Fringilla $52^h.4$ (1979) and finally 182 Elsa with $80^h.00$ (1980), which corresponds to $3^d.33$.

Rotational rates of 1^d or $0^d.5$ are difficult to observe, and there may be quite a large number of asteroids showing rotations much longer, but never observed, as phase and/or geometric effects cover the variability due to rotation only, if amplitudes are small.

Lightcurves

Observed lightcurves mainly represent the geometric configuration – either we get double-mode lightcurves with primary and secondary extrema with amplitudes between 0.00 and 1.50 mag, or single-extremum lightcurves if variations are caused only by albedo spots on the asteroid surfaces – but both effects can be present at the same time. Frequently we remarked that we had to double the value of a period (or got half the value) obtained earlier, because of those effects. But also more complex lightcurves do show up with well defined triple extrema, and we leave it to the reader to imagine an interpretation of such a lightcurve in terms of asteroid configuration.

The form and amplitude of a lightcurve is changing if observed at different aspect configuration, representing the changing triangle asteroid-sun-earth, and due to different views onto the asteroid rotational pole. Under special conditions and with accurate timings of extrema it is possible to obtain the orientation of the axis and even the sense of rotation.

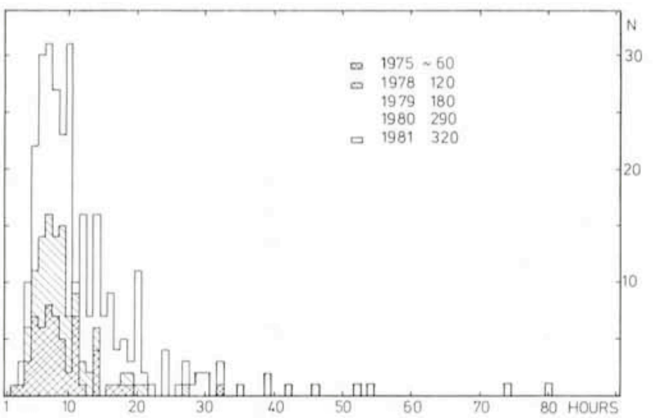

Fig. 1: *The frequency distribution of known rotation periods of asteroids (many of them observed at ESO). Before 1975 the longest rotation period observed was 20 hours – today we reach 80 hours or 3.33 days.*

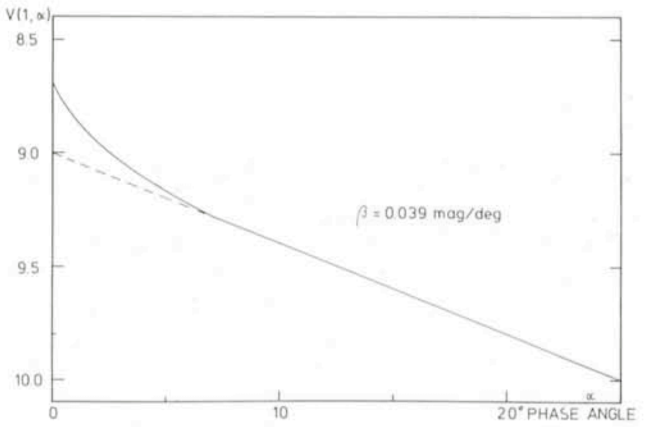

Fig. 2: *The mean magnitude phase relation of an asteroid, where V (1, α) is reduced to unit distances (1 AU), showing an opposition effect at smaller phase angles.*

In this article I do not show lightcurves as this was done earlier in "The Messenger" No. 13, p.3 (J. and A. Surdej, 1978), No. 18, p.27 (Debehogne, 1979) or No. 22, p.5 (C. I. Lagerkvist, 1980).

Magnitudes and UBV Data

Though my main goal is not to get a survey of UBV data, they should be determined each time when observing an asteroid. The magnitude V is essential to get out of a completely observed lightcurve a mean magnitude at a given phase angle. Drawing a plot of magnitudes against solar phase angles we get a phase coefficient, usually about 0.039 mag/deg, but values of 0.015 or 0.050 are not uncommon and conclusions about the surface texture may be obtained. Fig. 2 shows, for a fictive asteroid, that the relation between about 7 – 20 degrees is linear; but starting with 7 degrees down we have an opposition effect, the nonlinear increase of brightness, with a number of possible explanations for this effect, such as changing reflection properties, shadowing effects, or a new multiple-scattering theory, including the knowledge of macro- and microscopic surface properties. Phase coefficients may be different for S and C type asteroids, but still it is up to the user to make his own choice. To obtain the phase coefficients (at least when observing at ESO for short runs only!) it is necessary to cooperate with other observers carrying out a similar programme.

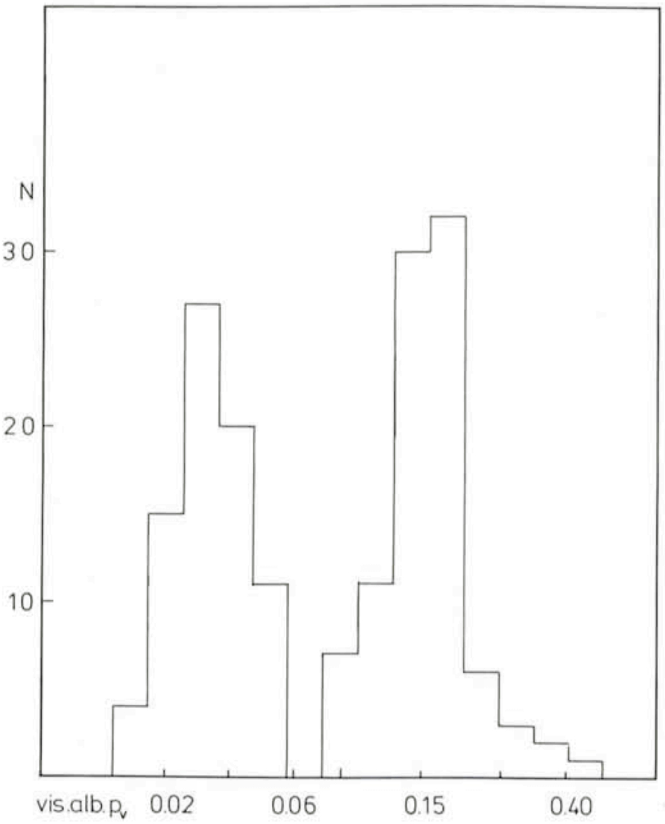

Fig. 3: *The bimodality of asteroids, based on the geometric visual albedo p_v (D. Morrison and L. A. Lebofsky in "Asteroids" p.184, ed. Gehrels T., 1979.*

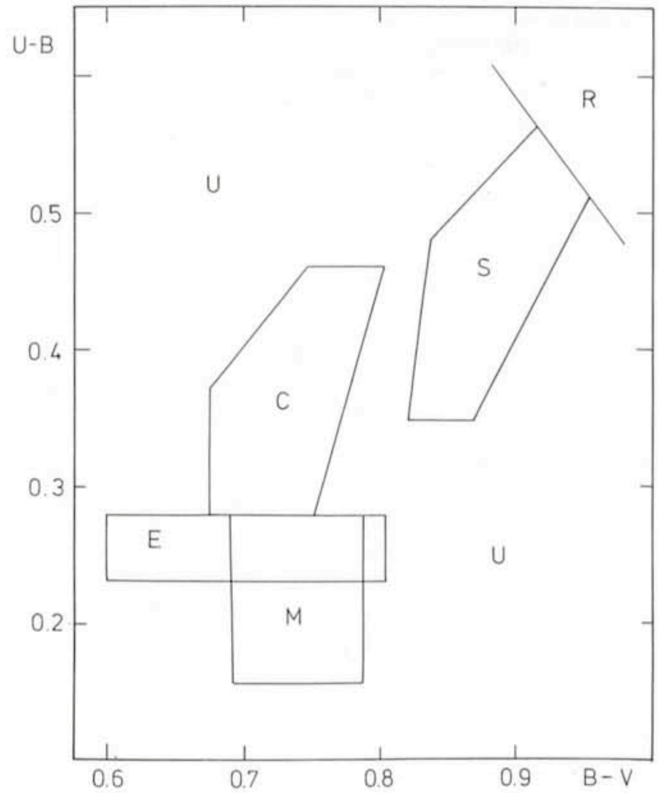

Fig. 4: *Simplified domains of asteroid types C, S, M, E, R from UBV Colours as obtained by E. Bowell et al. (Icarus* **35,** *313, 1978).*

Speaking about C or S types, a taxonomic system to describe asteroids was introduced. Most asteroids fall into two major groups, bright S-types (stony irons, silicaeous) with moderate high albedo of 0.15, and dark C-types (carbonaceaous, chondrites) with only about 0.03 – 0.05 albedo. The two groups definitely exist as shown by the measurement of the albedo by polarimetric or radiometric methods, as indicated in Fig. 3. In addition to that we know of a few more groups, such as M asteroids (metallic), E, R and U (unusual). The two-colour diagram B-V/U-B in Fig. 4 shows the domains where different types seem to be concentrated. Of course, colours are not the only parameters for the classification.

Though there would be much more to say about that new interesting field in astronomy dealing with well-known objects so near to us, I want to finish this short review with a remark:

I have to thank especially ESO for making available to me so much telescope time, though Austria is not (yet) a member state – and last not least our Austrian "Fonds zur Förderung der Wissenschaftlichen Forschung" which helped to balance the travel budget.