THE NEEDS IN THE RADIAL VELOCITY AREA IN VIEW OF IMPENDING SPACE ASTROMETRY PROJECTS

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I have understood the title of this talk given to me by Dr. Westerhout to imply a review of our present ability to provide new radial velocity measurements for the many stars to be observed by the Space Astrometry projects, as well as an indication of the technical developments still required. And indeed, the quantity and quality of the existing radial velocity determinations are such that only a small fraction of the data needed can be considered available.

The challenges presented by the two projects, the Astrometry Satellite and the Space Telescope, are somewhat different, corresponding to the complementary nature of the two programmes: The dedicated Astrometry Satellite will observe a very large number of relatively bright stars, while the Space Telescope is expected to give astrometric results for much fainter, but also far fewer objects (estimated currently at perhaps 20 per year). The two programmes will therefore be considered separately.

The Astrometry Satellite

The standard programme considered consists of 100,000 stars of average magnitude 10-11, and three observations per star are required to detect a reasonable fraction of the variable objects. Radial velocities are not necessarily needed for all the programmes proposed to now, but a check on duplicity is probably always desirable. Further, following up all variable objects to determine a rough velocity curve and mean velocity implies approximately a doubling of the total number of observations, which will therefore hardly be less than 300,000. At the ESA meeting on this programme in June 1976, I estimated the effort required as follows: I assume that with an efficient setting technique of a computer-controlled telescope one can set and centre on a star in 30 sec., and require that the average integration time be equal to this. One then finds that a telescope of size 1-1.5 m is required, and with this one would get some 500

Patrick A. Wayman (ed.), Highlights of Astronomy, Vol. 5, 805–807.

https://doi.org/10.1017/S1539299600004779 Published online by Cambridge University Press

observations per night. Thus, from a good site one could complete the programme in one year for each hemisphere; if only full-moon time were available, it would be two or three years. This of course assumes adequate staffing and computing support.

In 1976, this estimate was based on the expected performance of CORAVEL, the Griffin-type radial velocity spectrometer built jointly by the Geneva and Marseille observatories. The description of the actual performance of this instrument by Dr. Mayor at the meeting of Commission 30 (to appear soon in Vistas in Astronomy) confirmed that these expectations are more than fulfilled. The tool needed to measure radial velocities for F5-M stars with the desired speed and precision is thus already at hand.

There remains, however, the difficult problem of developing equally efficient methods to deal with the remaining stars. These are first of all the early type stars (O-F5), but also perhaps Wolf-Rayet stars, carbon stars, emission-line stars, etc. The applicability of CORAVEL to a wide range of the later spectral types is of course due to the predominance of FeI and other neutral metal lines in all these spectra, combined with uniformly low axial rotation. In the range of early-type stars, the line spectrum and therefore the characteristics of any mask used to match it, changes dramatically with spectral type, and a very wide range of rotational velocities is observed. In addition, there is an abundance of peculiarities like double-lined or composite spectra, Am and Ap stars, β Cep or δ Scu stars, emission-line or shell spectra, etc.

In principle, the "simple" solution to this problem consists of recording the whole spectrum on a multi-channel detector at suitable resolution and sort out the problems in the computer with a programme able to detect and handle all these different types of spectra. If cleverly done, this instrument could (in fact, should) at the same time automatically provide good spectral classification and perhaps even the photometry to the extent possible from the ground. All stars would be handled in the same way, so no previous knowledge of spectral type would be needed. Turning this ideal into an actual instrument working routinely at the telescope appears to me to be the greatest challenge in the field of radial velocity instrumentation in the next few years-- and those years are few if the Astrometry Satellite is launched on schedule.

The Space Telescope

For the stellar objects, the ideal instrumentation should be the same as that already described. With so few objects to observe, it should not be difficult to devote the necessary time, even on large telescopes, to compensate for their faintness. This is no doubt also true for the non-stellar objects, which will certainly also be the subject of intense studies from the ground.

Two types of objects which may be observed with the Space Telescope are close visual binaries and astrometric binaries with low-mass companions (read: planets). For these, radial velocity measures of very high precision may be required in order to confirm any small orbital motions at the limit of detection, or to convert the visual orbit into an absolute one if the parallax is not known to sufficient precision. Here also, we may note that the instrumentation is already available: Several independent groups have developed instruments capable of measuring radial velocity changes of a few m/s. It remains to be seen whether <u>any</u> stars have velocities constant to this level or precision.

Conclusion

The methods of observation, essentially already available for late-type stars, need considerable developmental work in order to reach a comparable state of perfection for the earlier spectral types. Nevertheless, the task of obtaining radial velocity measurements for the stars observed in the Space Astrometry projects, although large, should not be in any way overwhelming if supported by an effort which, compared to the space projects themselves,is really very modest indeed.

https://doi.org/10.1017/S1539299600004779 Published online by Cambridge University Press