power law exponent seems to be well determined.

This non-linear response explains why the IDS sometimes gives poor sky cancellation even when very high signal-to-noise ratios are achieved. If ϱ is the ratio of the input photon rate from the sky to the rate from the star and if R is the ratio of the observed star signal to the signal that would have been observed in the absence of a sky background then clearly

$$R = (1+\varrho)^{1.04} - \varrho^{1.04}. \quad (2)$$

This reduces to

$$R \approx 1.04\,\varrho^{0.04} \quad (3)$$

if $\varrho \gg 1$, and similarly, if $\varrho \ll 1$ then,

$$R \approx 1 + \varrho\,[1.04 - \varrho^{0.04}]. \quad (4)$$

Strong night sky emission lines will leave a positive residual that can be quite large unless the star signal is also very strong. In addition, emission line intensities in the star signal will be slightly overestimated if there is a strong sky or star continuum background.

Besides the non-linearity in the system response as a function of intensity there is a non-linearity to the system response as a function of time. The output signal of the IDS increases with increasing exposure time. This was first noted by P.M. Rybski (*Bull. A.A.S.* **12,** 751, 1980). According to Rybski the phenomenon is repeatable and intensity independent. Thus it is possible to avoid the most serious errors by adopting proper observing procedures. Wills, Netzer, and Wills (*Ap. J.* **288,** 94, 1985) describe one such technique in the appendix to their paper on broad emission features in quasars. It is clear that if the integration periods used on the program objects are significantly greater than the integration periods used for standard stars, the program stars may appear systematically brighter than they actually are by a few tenths of a magnitude. In any case very short exposure times on the standard stars should be avoided.

The causes of these non-linearities are unknown to me. As Rybski (*Bull. A.A.S.* **12,** 751, 1980) has pointed out, a model with an exponential decay and a power law increase approximately fits his data. Deviations from this simple model might account for the effect seen in the non-linearity of response of the detector to different input light intensities. One could speculate that metastable states in the phosphor screen increase the efficiency of the phosphor as the input photoelectron flux increases. Clearly all detector systems that work by measuring the intensity of the phosphor screens of image tubes might be expected to show similar response characteristics.

The effects listed above are important at the 5 %–20 % level but they can be corrected to the 1 % level. With care, and with proper attention to the standard star calibration it should be possible to obtain absolute spectrophotometry accurate to a few percent with the IDS system.

I would like to thank Peter Shaver and Michael Rosa for their suggestions and help in improving this note.

Rotational Velocity of F-type Stars

G. Noci[1], S. Ortolani[2] and A. Pomilia[1]

[1] *Istituto di Astronomia, Università di Firenze*
[2] *Osservatorio Astronomico di Asiago*

The rotation is a general property of celestial objects, which is probably generated by the vorticity of the interstellar matter. Obviously, stars forming from turbulent vortices conserve some of the initial angular momentum, depending on the early formation history. It is well known that there is a well-determined trend of the rotational velocity of main sequence and giant stars with the spectral type. This is shown by the continuous and dashed curves of Figure 1, which are from the paper of Bernacca and Perinotto (*A.A.,* **33,** 443, 1974). Early-type stars have high rotational velocities, while late-type stars are slow rotators. There is a sharp drop in the velocities from F0 to F5, particularly for main sequence stars: stars later than F5 have all very little angular momentum. This has been attributed to the presence of planets around late-type stars, which would contain most of the angular momentum of the system, as it happens in the case of the solar system. The angular momentum is probably transferred during the T Tauri pre-main-sequence phase. Another possibility suggested for the rotation velocity drop is the loss of angular momentum caused by stellar winds, which should occur for stars having convective layers close to the surface, i.e. late-type stars.

Hence the study of the stellar rotation is of great importance in astrophysics and, in particular, in the study of planetary formation. Recent studies show that fast and slow rotators differ also in other properties. It appears (Pallavicini et al., *Ap.J.,* **248,** 279, 1981) that G to M type stars have the rotational velocity proportional to the X-ray luminosity, while for early-type stars there is no such correlation, but rather a correlation between X-ray luminosity and bolometric luminosity.

In the case of late-type stars, the superficial magnetic fields, which are thought to be the cause of the X-ray emission in these stars, are due to a dynamo process which depends on the rotational velocity. F-type stars are important because at this type there must be the transition to a different mechanism

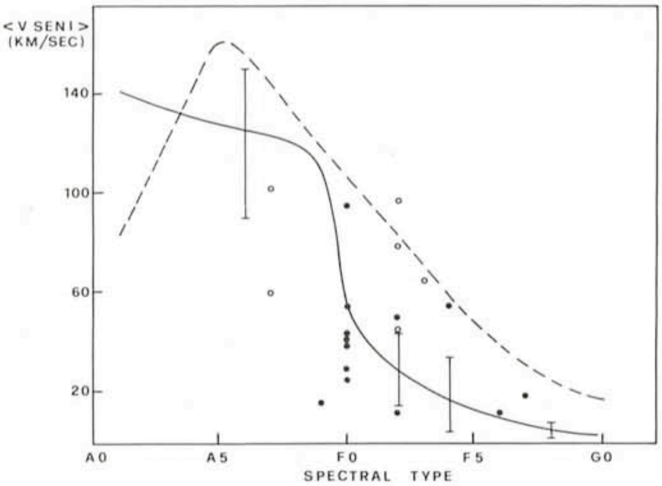

Figure 1: *Rotational velocity vs. spectral type. The continuous and dashed curves (for main sequence and giant stars) are taken from Bernacca and Perinotto (1974). Open circles: giant stars. Filled points: main sequence stars.*

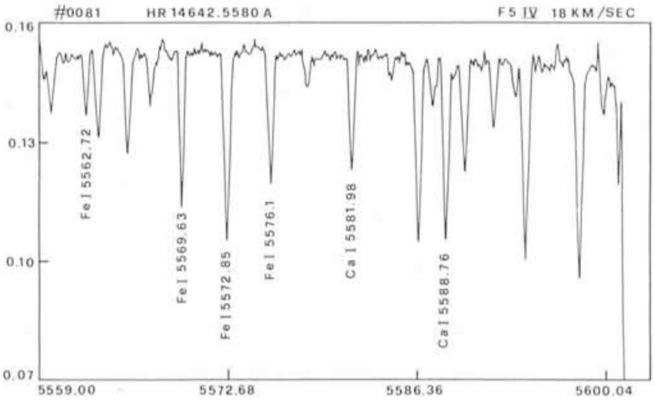

Figure 2: *CES spectrum of the star HR 14642. Some of the most prominent absorption lines are indicated. The star has a rotational velocity v seni = 18 km/sec.*

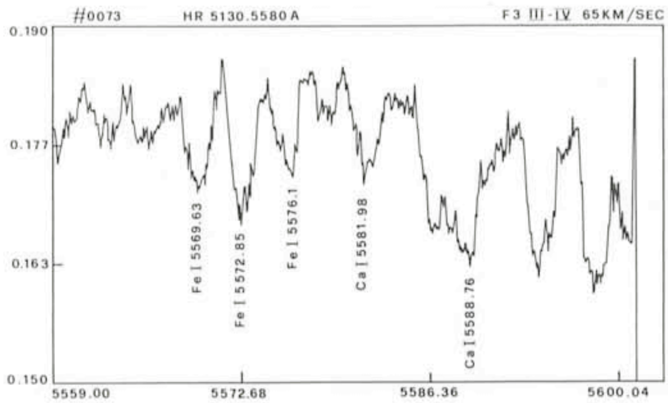

Figure 3: *CES spectrum of the fast rotating star HR 5130 (v seni = 65 km/sec). The wavelength scale is the same as in Fig. 2.*

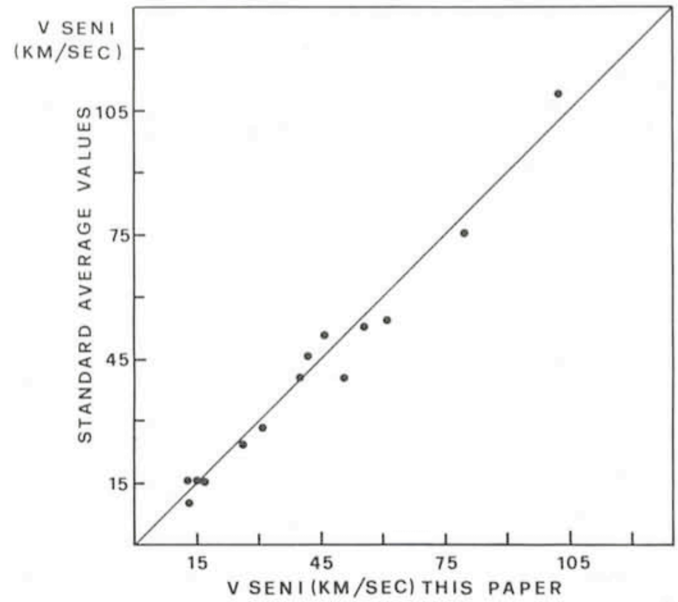

Figure 4: *Rotational velocities calculated with the cross correlation method plotted versus weighted averages from other authors.*

of X-ray production. The number of F-type stars analyzed so far for rotational velocity is not large. To increase this number we observed a sample of 15 bright, X-ray emission stars at La Silla with the 1.4 m CAT telescope equipped with the CES.

Observations with the CAT

The rotational velocity of a star can be measured, following the classical procedure, from its broadening effect on the photospheric absorption lines, caused by the Doppler effect.

A simple cross correlation between the spectrum of the star to be measured and that of a template star was used to measure the observable quantity, namely v seni (v is the equatorial rotation velocity, i the angle between the rotation axis and the line of sight). The quality of the spectra is very high, with a resolution of about 80,000, as measured from a laser line. Figures 2 and 3 show two of the spectra obtained during the observations carried out in December 1983 and April 1984. The lines are well defined and the rotational broadening appears evident comparing the two spectra; the spectral region selected is the result of a compromise between the spectral sensitivity of the detector/spectrograph and the need to have several unblended lines of intermediate intensity.

To check our results we have observed, beyond the sample quoted above, 14 stars of known rotational velocity. The velocities obtained by us are plotted in Figure 4 versus the velocities obtained by other authors (weighted averages): the high accuracy of our results and the absence of a systematic deviation are remarkable.

Given the fact that our results appear to be among the best available so far, we are confident that the knowledge of the X-luminosity/v seni relation will be improved. However, we have not yet all the available X-ray data. A comparison of the obtained v seni values with the spectral type confirms the results of previous observations (Fig. 1), both for main-sequence and giant stars. (It must be taken into account that seni can be very small for some stars.) A more extended project, which concerns a wider range of spectral types and includes also echelle spectra obtained at the Asiago Astrophysical Observatory, is under development.

Visiting Astronomers (October 1, 1985 – April 1, 1986)

Observing time has now been allocated for period 36 (October 1, 1985 – April 1, 1986). The demand for telescope time was again much greater than the time actually available.

The following list gives the names of the visiting astronomers, by telescope and in chronological order. The complete list, with dates, equipment and program titles, is available from ESO-Garching.

3.6 m Telescope

Oct. 1985: Kudritzki/Gehren/Husfeld/Hummer/Conti/Méndez/Niemela, Spite, M./Spite, F., Hunger/Heber, Brinks/D'Odorico/Ponz, Bergeron/D'Odorico, Alloin/Pelat, Caputo/Castellani/Saraceno/De Stefanis, Brahic/Sicardy/Roques, Danks/Le Bertre/Chalabaev/Bouchet, Danziger/Oliva/Moorwood, Moorwood/Oliva, Encrenaz/Lecacheux/Combes, Leinert/Dyck.

Nov. 1985: Leinert/Dyck, Marano/Zitelli/Zamorani, Röser/Meisenheimer, Butcher/Mighell/Oemler, Danziger/Rosa/Matteucci, Danziger/Gilmozzi/Kunth, Pizzichini/Pedersen, D'Odorico/Azzopardi/Lequeux/Prévot M. L., Rodono/Foing/Cutispoto/Scaltriti/Bonnet/Linsky/Butler/Haisch.