DYNAMICS OF THE DEEP SOLAR PHOTOSPHERE AT SUBGRANULAR SCALES

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1. Introduction

Extending our previous studies of the dynamics of solar granulation (Nesis *et al.*, 1997) we investigated the relationship between granular flow and the emergence of turbulence in the deep photosphere. Our main goal is to explore if such a relationship exists, and if so, to define it quantitatively. To this end we take advantage of the excellent signal approximation property of wavelets.The material for the present work is a series of spectrograms of high spatial resolution covering a time span of 12 min. They were taken at the center of the solar disk with the German Vacuum Tower Telescope in Izaña (Tenerife, Spain) in 1994, and include several absorption lines of different strengths; for more details see Nesis *et al.* (1997). The spectrograms were digitized and processed with wavelet techniques and regression analysis, in order to investigate the granular convective flow, the associated turbulence, and their mutual connection.

2. Results and Conclusions

Figure 1. shows the traces of the Doppler velocity (full line) and the turbulent velocity (dotted line) along the spectrograph slit. The Doppler velocity corresponds to the Doppler shift of the line core, whereas the turbulent velocity is reflected by the *fwhm* of the line. We found that granular flow speed and turbulence cannot be related by a regression line; rather the convective flow and the turbulence appear to be related by an attractor in the convective flow speed-turbulence phase space. The behavior of the regression analysis follows closely the history of the granulation dynamics over the entire 12 min time span, which corresponds roughly to a mean turn-over time of a granule (Mehltretter *et al.*, 1978). Thus, we tend to assert that convective flow and turbulence can be interpreted in terms of a dynamical system, which is shown

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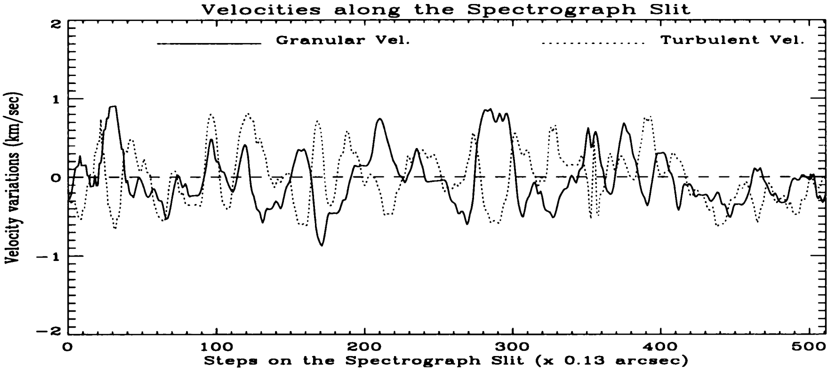

Figure 1. Doppler velocity and turbulent velocity.

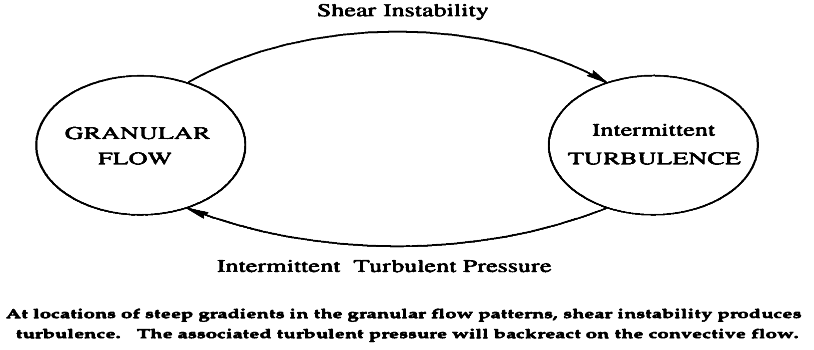

Figure 2. The dynamical system.

in Fig. 2. The calculated turbulent pressure shown in Table 1 supports this assertion.

TABLE 1. Hydrodynamical implications of our observations.

Re	ν_{turb}	P_{turb}	P_{turb}/P_{gas}	all values at
10^9	$10^8\,m^2s^{-1}$	$\leq 10^4$ Pa	≤ 0.5	$\approx \tau_{5000} = 1$

References

Nesis, A., Hammer, R., Hanslmeier, H., Schleicher, H., Sigwarth, M., and Staiger, J. (1997), *Astronomy and Astrophysics* **Vol. 326**, p. 851

Mehltretter, P. (1978), *Astronomy and Astrophysics* **Vol. 62**, p. 3