



# Synoptic program to measure the evolution of the photospheric hidden magnetic field during a solar cycle

by

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## Introduction

The solar photosphere is seething with a vast amount of magnetic flux tangled on scales much smaller than the resolution scale of solar telescopes, that can not be measured with usual techniques based on the Zeeman effect. High precision spectropolarimetry, however opens the possibility to investigate this hidden magnetism by considering the Hanle effect. In 2007, near a minimum of the solar cycle, we started a synoptic program (Kleint 2010, 2011) to explore possible variations of such hidden magnetic flux with the solar cycle, through the application of a differential Hanle effect technique (Stenflo et al. 1998) on scattering polarization observations of  $C_2$  molecular lines in the spectral region around 514.0 nm in the quiet Sun.

## The observations



Fig 1: The Gregory-Coudé telescope in Locarno, Switzerland

The observations are generally carried out with the cadence of about one month at the Gregory-Coudé telescope in Locarno (Fig.1). With the ZIMPOL polarimeter (Gandorfer et al. 2004, Ramelli et al. 2010) we achieve a polarimetric resolution of the order of  $10^{-5}$ , thanks to a fast piezo-elastic modulator (42 kHz) and a synchronous demodulation, done with a special dedicated CCD-camera. As a result of the fast modulation, seeing induced effects are avoided. The scattering polarization measurements are obtained with the spectrograph slit set parallel to the solar limb at a distance of about 5-10 arcsec from it (i.e.  $\mu = \cos\theta = 0.1-0.15$ ). The slit subtends a solar region along 180 arcsec. A set of five observations is usually carried out in five heliographic positions: North (N), North-West (NW, lat=+45°), West (W), South-West (SW, lat=-45°) and South (S). Including all calibrations (polarimetric, dark, flat-field), this set of observations takes about half a day.

Since beginning of this synoptic program, several improvements were applied to the instrumentation, such as the deployment of the new version III of the ZIMPOL system in 2010 (Ramelli et al. 2010) or a new silver coating of the mirrors. Thanks to them it was possible to increase the observing efficiency. A limb tracking system and other automatic systems allowed to fully automatize the observing procedure.

## Results

An example of the linear polarization profile ( $Q/I$ ) obtained in a typical observation, is shown in Fig. 2. The four marked peaks represent the  $R_1$ ,  $R_2$ ,  $R_3$  and P spectral components of the  $C_2$  molecules considered in this synoptic program.

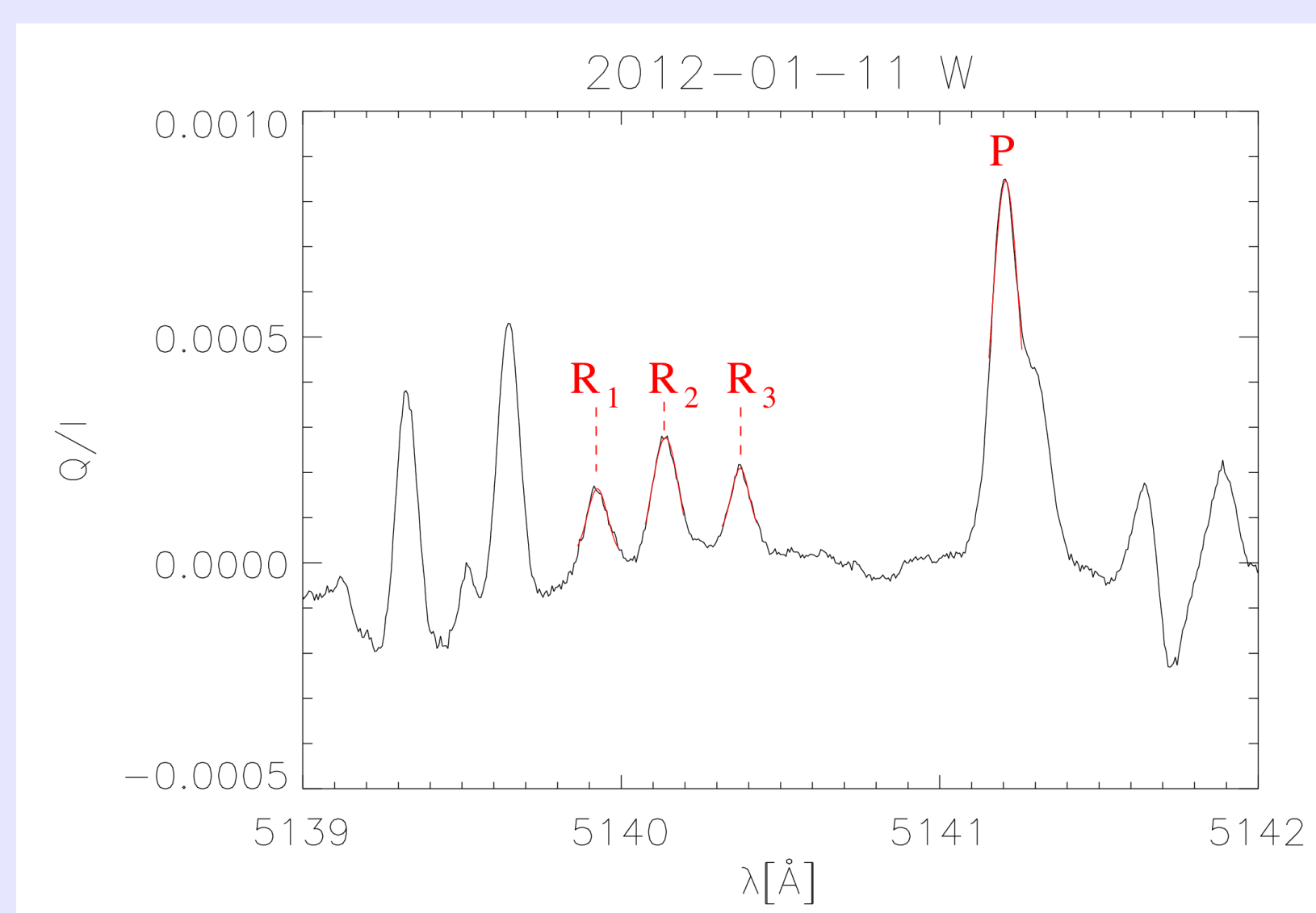


Fig. 2: Typical linear scattering polarization observation (Stokes  $Q/I$ ) of  $C_2$  spectral line components obtained near the solar limb.

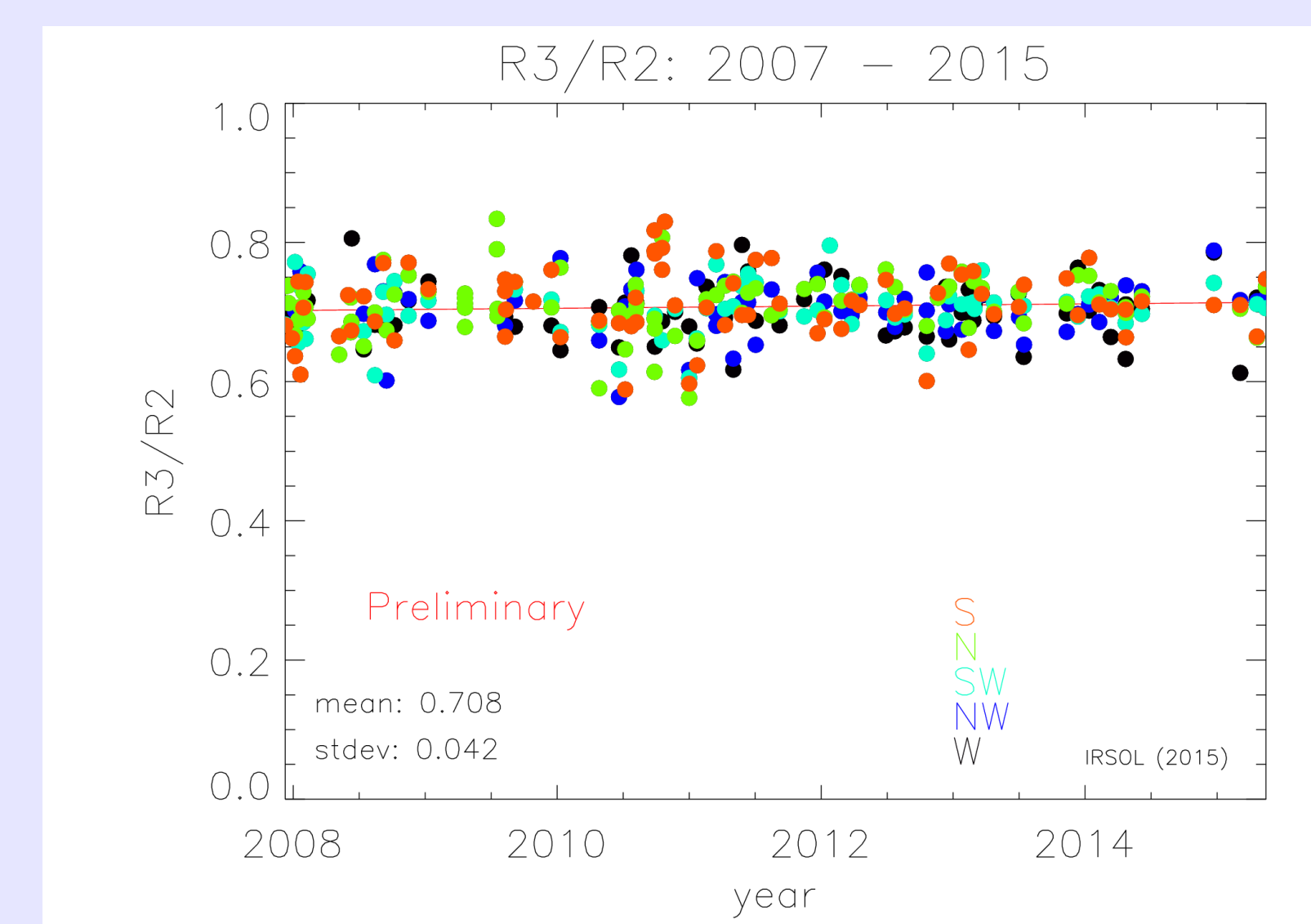
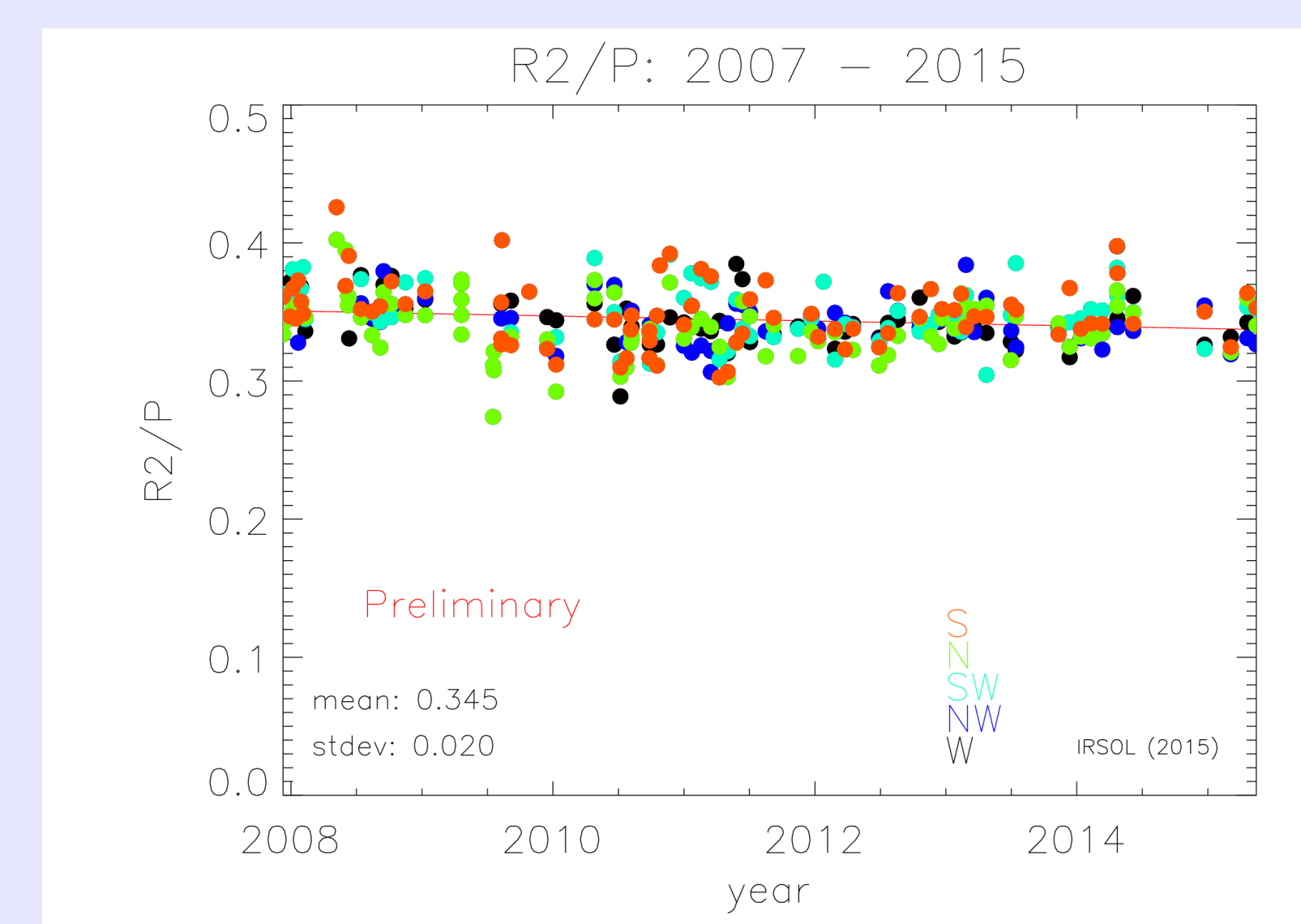
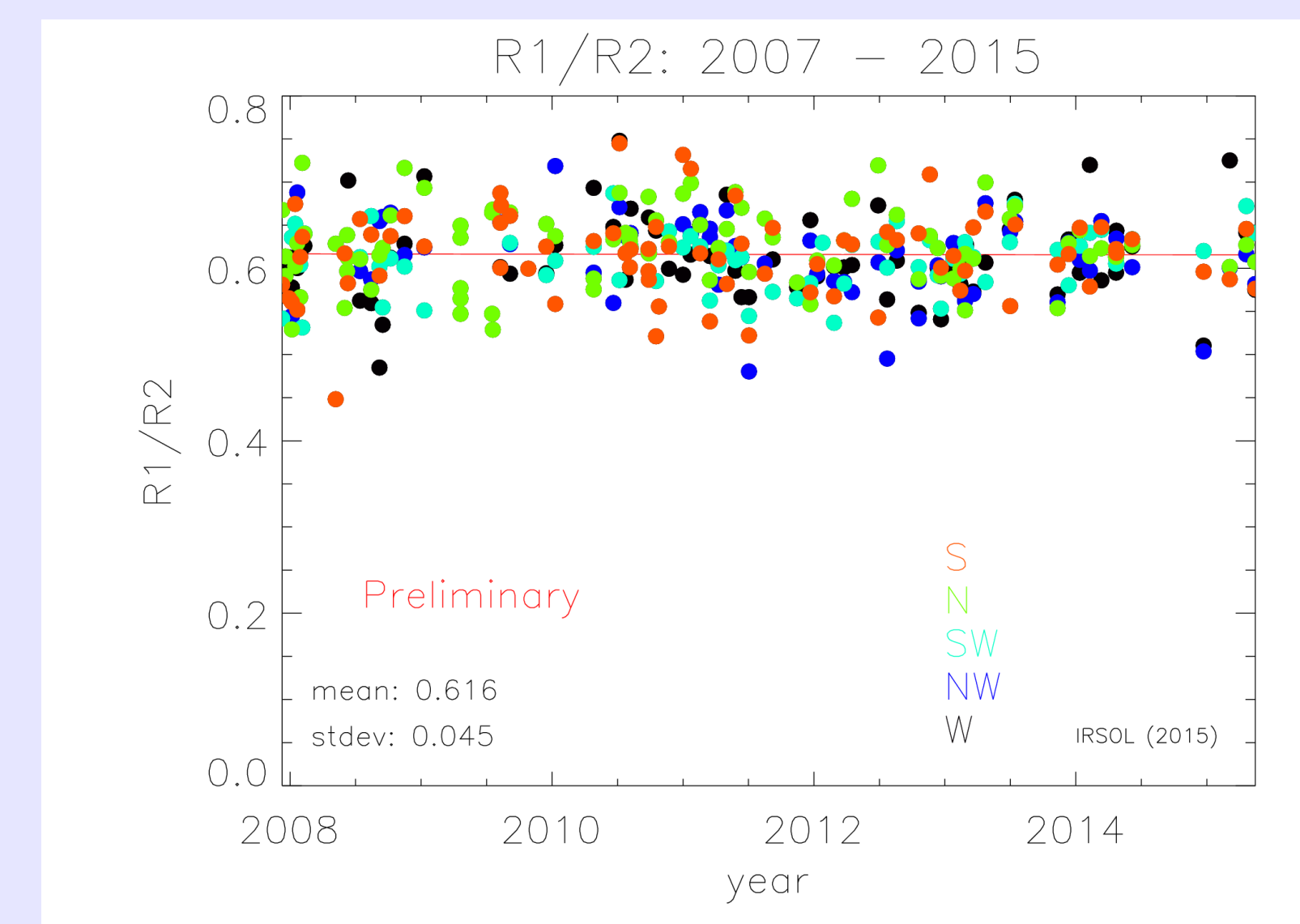


Fig 3: Ratios between the  $Q/I$  peaks of the different  $C_2$  components.

The ratios of the peak amplitudes obtained until now in the observations, which include both the minimum (2009) and the maximum (2014) of the present solar cycle, are reported in Fig.4. Even if the data analysis is still going on, from a first preliminary analysis we do not see large variations with the solar cycle in the amplitude ratios. This would lead us to think that the turbulent unresolved magnetic field strength, that was inferred as  $7.41 \pm 0.76$  G by Kleint et al. (2011) with first data set obtained during the solar minimum, stays almost constant. If this apparent constancy is confirmed through the current cycle, then it will have important implications, since it provides hints on the existence of a local dynamo effect at granular and sub-granular scale, uncorrelated with the global magnetic field varying with the solar cycle.

## References:

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