Quiet Sun and its Dynamics as Viewed from the Ground and from Space

K. Tziotziou

Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, National Observatory of Athens, GR-15236 Penteli, Greece; kostas@noa.gr

Abstract. Over the last years, state-of-the-art ground-based and/or space-based observations using imaging, spectroscopic and spectropolarimetric instruments, at a wide range of wavelengths, reveal that the quiet Sun, just like active regions, is a highly inhomogeneous and dynamic environment that plays an important role in the dynamics of the entire solar atmosphere. This dynamic quiet Sun is manifested through a number of different types of features and phenomena that occur in a large range of spatial and temporal scales and are nowadays believed to be mostly driven by the local magnetic field and its dynamics. Ground-based observations processed with state-of-the-art, post-processing reconstruction techniques, often combined with simultaneous space-based observations from a variety of instruments on different spacecraft, offer a unique opportunity to investigate and understand the physical conditions of the local plasma, the nature, formation mechanisms and evolution of quiet Sun phenomena and possible interrelationships between quiet Sun phenomena occurring at different heights of the quiet Sun solar atmosphere, from the photosphere and chromosphere to the transition region and low corona. We provide a comprehensive review of our latest understanding of quiet Sun and its dynamics as viewed from the ground and from space and discuss the advantages/disadvantages of ground- and space-based observations and future advents in solar observations with new solar instruments.

1. Introduction

During the 11-year solar cycle, the solar surface exhibits both active and quiet regions, during the maximum, while during the minimum the Sun is mostly quiet. In active regions (ARs), flux emergence is intense and localized (∼ 10^{22} Mx, see Schrijver & Harvey 1994) and creates strong opposite-polarity regions with large amounts of stored free energy that are released in violent phenomena such as flares and coronal mass ejections (CMEs). Contrary to ARs, the quiet Sun typically characterizes regions of the Sun that exhibit continuous but modest flux emergence in the interior (internetwork; IN) of large convective cells called supergranules. This flux emergence occurs mainly in the form of bipolar elements that are driven by the supergranular flow towards the supergranular boundaries. There, opposite polarity fluxes cancel and like-polarity fluxes merge (Wang et al. 1996; Schrijver et al. 1997; Gočić et al. 2014), forming the magnetic network which consists of hierarchic flux concentrations having magnetic flux elements of ∼ 10^{18} – 10^{19} Mx and typical diameters of 1000-10000 km (Schrijver et al. 1997; Parnell 2001).

Several small-scale structures, among them mottles/spicules, reside in the magnetic network (see the review by Tsiropoulou et al. 2012, for further details), however