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Observations and analysis of NOAA AR 11429 at KSU-Astronomical Observatory

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ABSTRACT

We study the evolution of the sunspots in the recent super active region NOAA 11429, which spawned a powerful X5.4/3B flare on March 07, 2012 (2^{nd} on record occurred since 2010), associated with a wide and fast Coronal Mass Ejection (CME; Halo/070036) and a large proton flux event (6530 $p.f.u$). The sunspot group consists a rare example of "*Island Delta*" in $\beta\gamma\delta-$ magnetic configuration. This active region dominated the Solar activities on the northern hemisphere during the period March 03–15, 2012, of the present Solar Cycle 24, erupting 2 X-class flares, 13 M-class flares, and about 32 C-class flares.

We analyze white-light images, wavelengths around 540 nm, observed at the Astronomical Observatory of King Saud University (AOKSU). The observations are part of a campaign conducted locally since early 2012, for monitoring Solar activities on a daily basis. The observations and data reduction are presented and discussed. We examine the main properties of AR 11429 (i.e. structure, growth and decay) by computing its daily "area" and "tilt- & trend-" angles, and infer information about its development and dynamics. The area curve is found to show three distinguishable phases, nicely fitted adopting double-Gaussian distribution. A close relation between sunspot group area and tilt-angle with the major March 07 powerful flare can be noticed from the current results, that certainly necessitates deep and careful inspections through studying large sample of events.

The follow-up of the sunspot group the period it inhabits the Solar photosphere, permits exploiting the proper motion of four long-lived individual spots, as well as tracing the local surface differential rotation, found to be consistent with empirical results.

1. Introduction

Understanding the Solar active regions (ARs) and their related phenomena is one of the main quests of nowadays modern Solar physics. Although great achievements have been accomplished in performing Solar observations with both high angular resolutions and very short-time cadence imaging (i.e. ground-based telescopes such as: DOT, DST, STT, VTT, THEMIS, BBSO-NST; and space-based telescopes such as: SDO, SOHO, HINODE, RHESSI, STEREO), much still to be revealed, especially providing an understanding to the observational peculiarities of active regions and their associated phenomena (i.e. triggered physics, structure and dynamics). In particular, the accepted physical theoretical models can be questioned when dealing with special cases of complex sunspot groups such as "$\beta\gamma\delta$", those having a strong effect to the space weather and almost hosting the to-date observed most large solar eruptive events, especially energetic flares and fast-speed CMEs (Sammis et al., 2000). The magnetic fields in such sunspot groups are usually very complicated, structure and evolution (Liu and Y, 2001; Schmieder et al., 1994). Thus, observing and tracing the nature, growth, motion and decay of $\beta\gamma\delta-$ class groups might offer a unique opportunity to exploit and test the present understanding of the related processes that drive these Solar events (i.e. magnetic field-plasma interaction; coronal loops/prominences and reconnection events; magnetic flux tubes structure and emergence; turbulent convection; differential rotation).

In the present paper we report some first results of monitoring Solar activities on a daily basis. Indeed, starting early 2012 we conducted an observational campaign at the Astronomical Observatory of King Saud University[1] (AOKSU). Our project coincides with the rise in activity of the present Solar cycle (i.e. cycle 24). Based on observational data, such as the smoothed SS number and 10.7 cm radio flux values, the minimum of cycle 24 is estimated to have occurred around December 2008 with an expected next

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[1] The Astronomical Observatory at King Saud University was originally established and inaugurated in 1976. Moved to a new location by 1985, the telescopes (domes) have been installed on the roof of the College of Science. More details about the observatory can be found at the IAU Newsletter-issue 74; (Elmhamdi et al., 2011).

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