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1 Introduction

Abastumani Astrophysical Observatory, Town Department of Solar Physics, Kazbegi ave. 2a, Tbilisi 380060, Georgia In the course of last 24 month solar research in the Georgia (including optical and radio observations) is performed mainly at the Abastumani Astrophysical Observatory of the Georgian Academy of Sciences (Mount Kanobili); observational data analysis and theoretical aspects of the investigation of the solar structures - in the Town Department of Solar Physics and in the Center for Plasma Astrophysics of Abastumani Observatory (Tbilisi). The main description of the Georgian instrumentation has been presented in the JOSO 1999 Annual report. Scientific investigations were continued these years in accordance with the fields of research list published in our previous National Report. Here we show only the most important solar physics researches in 2002-2003.

2 Abastumani Astrophysical Observatory - AbAO (Mount Kanobili)

2.1 Observations

- Series of full-disc photosphere and chromosphere images, radio observations of the Sun at the 9.26 GHz, study of solar cycle activity.

3 Study of the Solar Rotation

3.1 Quasi-periodic oscillations in sunspot plasma

The time and spatial characteristics of selected large sunspots from the AbAO photoheliogram collection (1950-1990) have been studied. The variations of sunspot angular rotation velocity residuals and oscillations of sunspots tilt angle were analyzed. It has been shown that the differential rotation rate of selected sunspots correlates on average with the solar cycle. the deceleration of differential rotation of large sunspots begins on the ascending arm of the activity curve and ends on the descending arm reaching minimum near the epochs of solar activity maxima. This behavior disappears during the 21st cycle. The amplitudes and periods of sunspot tilt-angle oscillations correlate well with the solar activity cycle. Near the epochs of activity maximum there appear sunspots with large amplitudes and periods showing a significant scatter while the scatter near the minimum is rather low. There is also found evidence of phase difference between the sunspot angular rotation velocity and the amplitudes and periods of tilt-angle oscillations (Khutsishvili et al., 2002).

3.2 The N-S asymmetry of the solar differential rotation

The properties of the differential rotation of the Sun are investigated by using of hydrogen filaments as tracers. Annual average angular velocities of 716 quiescent filaments are determined from H-alpha photoheliograms of the Abastumani Astrophysical Observatory film collection for the years 1957-1993. A rigorous regression analysis confirms the existence of the N-S asymmetry of the solar rotation. It is found that the northern hemisphere rotates faster than the southern one during even cycles (Nos. 20 and 22) and slower during odd cycles (Nos. 19 and 21). At solar activity maxima T-a-statistics reaches an extremum changing the sign from cycle to cycle at solar activity minima. Therefore it is possible to conclude that the N-S asymmetry of solar differential rotation changes in a solar cycle. The difference between the "mean" rotation rates of the northern and southern hemispheres reaches a maximum at solar activity maxima changing the sign near solar activity minima (Gigolashviliet al., 2003a,b). A theoretical explanation of the N-S asymmetry in the solar rotation is offered. It is suggested that this asymmetry is balanced out by the dynamo mechanism, which works in parallel with the mechanism offered by us. It is concluded that the N-S asymmetry of the solar rotation should cause a difference in activity level between the northern and southern hemispheres (Gigolashviliet al., 2003c).

4 Theoretical Research

4.1 A new kind of interaction between magnetosonic and Alfvén waves

A new kind of interaction between magnetosonic and Alfvén waves is supposed in the limit of ideal magnetohydrodynamics. The physics of wave coupling is based on parametric influence when the periodical variation of medium parameters caused by magnetosonic waves leads to resonant amplification of Alfvén waves (Zaqarashvili and Roberts, 2002a,b,c). The mechanism can be responsible for generation of high-frequency torsional Alfvén waves (with the period of few tens of seconds) at photospheric level (Zaqarashvili and Roberts, 2002a,c) and energy transmission from 5-minute oscillation into Alfvén waves (Zaqarashvili and Roberts, 2002a,b), which may propagate upward into the corona and contribute to coronal heating.

It is shown that the periodic shearing motions lead to the resonant generation of magnetosonic waves with half the frequency of motions (Zaqarashvili et al., 2002). Consequently standing Alfvén waves can be quickly damped at velocity nodes transferring the energy into slow magnetosonic waves (Zaqarashvili at al., 2003b). The same mechanism can be responsible for the damping of coronal loop global kink oscillations (Zaqarashvili at al., 2003a).

A method for the observation of global torsional oscillation of solar coronal loop due to the periodical variation of a spectral line width is suggested (Zaqarashvili, 2003). The amplitude of the variation must be maximal at the velocity antinodes and minimal at the nodes of the torsional oscillation. Then the spectroscopic observation as a time series at different heights above the active region at the solar limb may allow to determine the period and wavelength of global torsional oscillation and consequently the Alfvén speed in corona.

4.2 The dynamical aspects in the upper atmosphere on magnetically disturbed days the nightglow observations from Abastumani

On the base of new theoretical results (Didebulidze et al., 2002; Didebulidze et al., 2003) of formation short-period atmospheric acoustic and gravity waves in the inhomogeneous meridional wind was investigated annual distribution short period oscillations of the mesosphere-lower thermosphere nightlow intensity (Didebulidze et al., 2003). It has been shown that the annual distribution of the oxygen green 557.7 nm line total nightglow intensity short-period variations increase on magnetically disturbed days and during equinox.

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