【Grant-in-Aid for Scientific Research (S)】

Broad Section B

Title of Project : High Precision Polarimetric Observation by a Balloon-Borne Solar Telescope: Revealing Conversion Processes of Magnetic Energy in the Stellar Atmosphere

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Keyword : Astrophysical Plasma, Solar Physics, Optical-IR Astronomy, Balloon instrument, International Collaboration

【Purpose and Background of the Research】

The **chromosphere** interfacing the photosphere of 6000K and the corona of over 1MK is not a simple intermediate atmospheric layer transmitting magnetic energy, but a region where strong non-linearity drives dynamic phenomena, such as turbulence, shocks, and jets. Because the dynamics are likely to be responsible for injection of non-thermal energies into the corona and the solar winds, the chromosphere is the most important target in the solar and stellar physics. In order to **understand the conversion process of the magnetic energy**, it is necessary to quantitatively observe the chromosphere together with energy generation by turbulent magneto-convection in the photosphere. In order to overcome the qualitative interpretation by conventional imaging observations, we acquire a **high-quality 3D magnetic and velocity fields for the first time by the SUNRISE balloon-borne solar telescope**. In this research, we develop a high precision spectro-polarimeter to be installed in SUNRISE. In addition, we carry out **numerical modeling of the dynamic phenomenon in the solar atmosphere**, and aim to clarify the conversion process of magnetic fields in the astrophysical plasma by direct comparison with the 3D data provided by the SUNRISE balloon observation.

【Research Methods】

(1) High resolution and precise polarization measurement by the balloon-borne solar telescope SUNRISE: SUNRISE is an international joint project equipped with a 1m optical telescope. It allows us to perform a seeing-free and continuous observation for a week in its flight from Sweden to Canada at an altitude higher than 35km. We will newly develop SCIP (SUNRISE Chromospheric Infrared spectro-Polarimeter) for precise spectro-polarimetric observation of NIR spectral lines sensitive to magnetic fields in the photosphere and the chromosphere. Its flight is planned for 2021. We aim to obtain temporal evolution of 3D magnetic and velocity structures, to capture propagation of MHD waves and a discontinuous magnetic structure suggestive of magnetic reconnection.

(2) Numerical modeling of the solar photosphere and chromosphere: We employ massive numerical simulations to reproduce key process responsible for the energy transfer and dissipation which are highly deviated from thermal equilibrium over multiple spatial and temporal scales. We plan to incorporate ionization and recombination of atoms by heating and cooling, because they are likely to affect the dynamic phenomena in the chromosphere. We apply state-of-the-art radiative transfer calculation to simulate polarized spectra radiated from the dynamic phenomena, which allows us to make direct comparison with the data taken by SUNRISE.

【Expected Research Achievements and Scientific Significance】

The Sun provides a unique site to deeply understand the conversion processes of magnetic energy by the observations with resolution, which can be applied in a wide range of astrophysical plasmas such as stellar winds and accretion disks where common processes are likely to work. Because a space-based spectro-polarimetry planned in 2020's is only SUNRISE, this research can provide the basis for a future large-scale satellite project by showing superiority of the observation.

【Publications Relevant to the Project】

・"Penumbral Microjets in Sunspot Chromospheres: Evidence of Magnetic Reconnection", Katsukawa, Y., Astrophysics and Space Science Library, 449, 201 (2018).
・"SUNRISE: Instrument, Mission, Data, First Results", Solanki, S., ApJL, 723, L127 (2010).

【Term of Project】 FY2018-2022

【Budget Allocation】 109,100 Thousand Yen

【Homepage Address and Other Contact Information】

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