Aug. 2014 version

Activity Report of the NAOJ Visiting Scholar Program

Host Project/Division: Division of Solar and Plasma Astrophysics Name of Host Scientist: Shin Toriumi

Name of Visiting Scholar: Valerii Pipin

Title: Visiting Professor

Period: from 17/04/03 to 17/06/30

I. Report from the visiting scholar

[i] Achievement during the period of stay (in comparison with the initial plan)

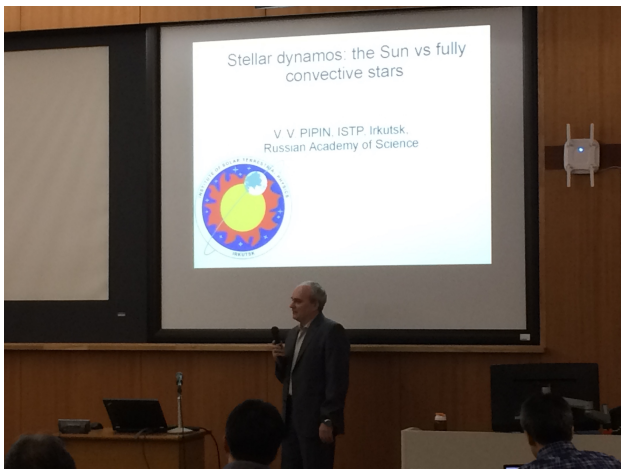
(Collaborative Research)

During my stay at NAOJ I have studied dynamo processes on the Sun and the late-type stars including partially convective and fully-convective stars. The set of stars include 9 stars which cover the spectral class ranging from G2 to M6. The stellar rotational periods within the set vary from 4 to 83 days. I applied the nonlinear mean-field dynamo models to calculate distributions of the large-scale flow and the large-scale magnetic fields inside each star from our set. Results of our calculations will allow to study the long-term variations of the magnetic characteristics and variations of the global flows induced by the large-scale magnetic activity. The most important results include: 1) for the first time we consider the nonlinear solar dynamo model with regards for the multi-tiered meridional circulation in the solar convection zone; 2) this model was employed further to study the young solar analogs rotating with periods of 11 and 5 days; it shows the decrease of the magnetic cycle period, the growth of the global flows variations, and change the topological properties of magnetic field with the increase of rotation rate for the young Sun; 3) the model shows change of the topological properties of magnetic field with the spectral class; we found the systematic increase of the strength of the poloidal components of magnetic field with the decrease of the stellar mass; for example, the model shows the non-axisymmetric polar field of strength 1.5 kG of the fast rotating M3 dwarf star (with mass of 0.3MS and period of rotation 4 days). I'm planning to summarize the results of the projects in several papers concerning the solar and stellar dynamo. Our results give a good base for collaboration with NAOJ about studying properties of the typical flare regions by means of the mean-field dynamo models. Using our models, we made preliminary estimations of the magnetic field loops parameters for the stars form our set. This study should be continued further. During my stay in Kyoto University we had a discussion with Prof Shibata-san's group about origin of stellar superflares and we agreed to coordinate our research in this topic.

In collaboration with Prof Nobumitsu Yokoi, we made study of the cross-helicity effect in the 3d large-scale dynamo. For the first time, it was found that the non-axisymmetric magnetic field on the stars with convective envelope can be generated solely due to the turbulent cross-helicity effect. When the poloidal magnetic field is strong, as it often met in the low mass main sequence stars, the near surface cross-helicity dynamo may provide important mechanism for formation of the large starspots from the poloidal magnetic field. The separate paper about this subject is in preparation.

(Education)

During my stay, I gave three lectures devoted to the basics of the mean-field electrodynamics theory and its application to solar and stellar dynamo problem. The lectures were done at NAOJ, University of Tokyo and Kyoto University.



[NAOJ Seminar on April 7th, 2017]

(Others)

[ii] Any comments on this program

I find the program extremely valuable, and I want to express my thanks for offering this chance to me. Certainly, I will recommend this program to other scientists, as well.

[iii] List of publications and presentations by the visiting scholar in collaboration with NAOJ staff or graduate students

Owing to results of study, several papers are in preparation: I) In collaboration with A.G. Kosovichev, “The Lambda effect and double-cell meridional circulation in self-consistent solar dynamo model”; II) The mean-field dynamo survey of late-type stars; III) In collaboration with S. Touriumi: “Large-scale dynamo and flaring magnetic loops parameters variations in late-type stars”; IV) In collaboration with N. Yokoi “Generation of polar starspots in large-scale cross-helicity dynamo”

II. 以下の項目について、受入教員が記入してください。

Report from the host scientist

[iv] 本制度に対する意見、要望など

Any comments on this program

客員の Pipin 氏には、滞在の 3 ヶ月間を通じ、太陽型星や晩期型星について恒星ダイナモの数値シミュレーションに取り組んでいただいた。研究費を活用して計算環境を向上させ、複数のダイナモシミュレーションを同時に進めることが可能となった。滞在中の成果はいずれも論文としてまとめているところである。また、京都大学でのセミナー講演では、柴田教授率いるスーパーフレアグループのメンバーと活発な議論が交わされ、将来的な共同研究についても話が及んだ。このように、本制度は国立天文台のみならず国内の天文コミュニティに広く貢献しうるプログラムであり、今後とも継続していただきたい。

研究部内での連携不足から、Pipin 氏への旅費支給の申請が帰国直前になってしまう事態があった。受入教員として反省するばかりであるが、このような状況でも迅速に対応していただいた事務部職員の皆様には厚くお礼申し上げたい。