The Global COE Program
"The Next Generation of Physics, Spun from Universality and Emergence"
Bilateral International Exchange Program (BIEP, invite) report

Send report to: Your responsible Professor in Kyoto University

gcoe-biep@scphys.kyoto-u.ac.jp , gcoe-office@scphys.kyoto-u.ac.jp

(Year/Month/Day)_2012/12/06_____

Invited Student

Name	Simon Candelaresi
University and Country	Stockholm University, Sweden
Grade	4th Year PhD student
Phone and FAX	+46 8 5537 8277
e-mail address	iomsn@physto.se
URL	www.nordita.org/~iomsn
Name and Position of Ph.D. advisor	Axel Brandenburg
e-mail address of Ph.D. advisor	brandenb@nordita.org

Responsible Researcher in Kyoto University

Name	Kazunari Shibata
Group and Faculty	Kwasan Observatory, Astronomy
Position	Professor
e-mail address	shibata@kwasan.kyoto-u.ac.jp
Phone and FAX	+81-75-581-1235

Research Project

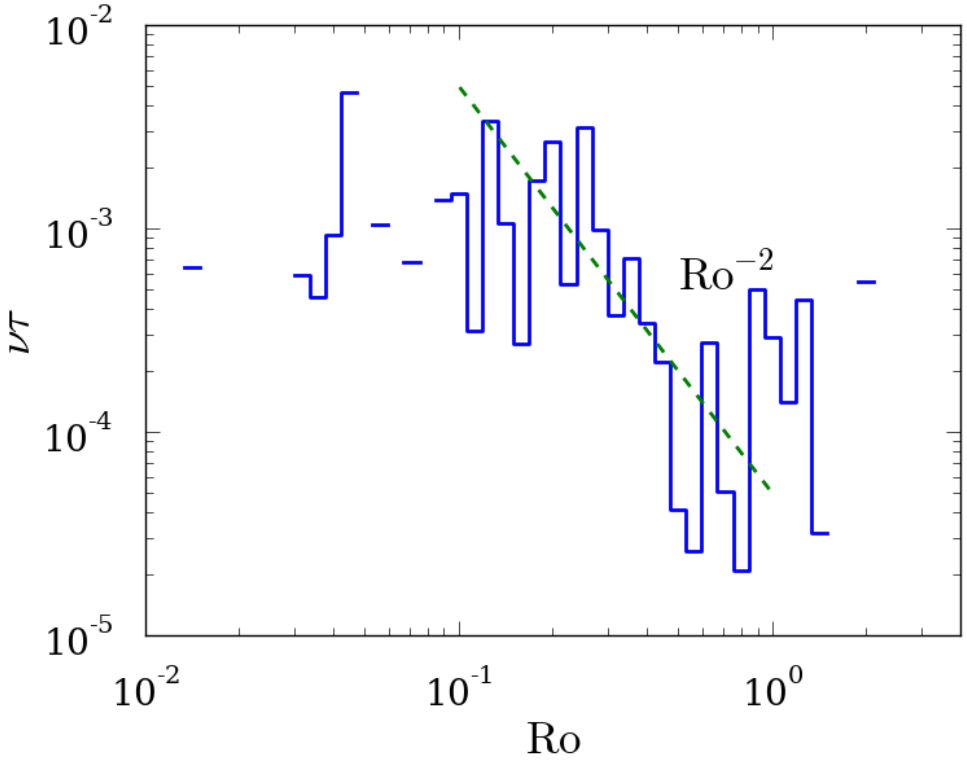
Title	Observational signatures of magnetic helicity in the local dynamo
Duration	5 weeks

Please summarize your activities and results during your stay in Kyoto University.
Also please describe how your stay has been beneficial to the graduate students in the host inst
You can add a sheet, if you need more space.
You can also write any comments and requests to the GCOE program.

The original purpose of this project was to investigate the dynamo processes of the Sun through comparison of theoretical models and Hinode observations, but on discussion on my arrival, we decided to extend the investigation to include thousands of solar type stars using data from the Kepler satellite. To investigate the magnetic activity of the stars, we used observations of superflares, a topic currently under research by Prof. Shibata's group.

Superflares, flares with energy of 10^{33} to 10^{39} erg, have been observed for solar type stars. How they are formed is an open question. Using the recent compilation of superflares from Kepler data (Maehara 2012), I investigated which conditions are favorable for flares of energies of 10**34 erg and above. Such conditions can be the rotation rate, the metallicity, the surface gravity, etc. As superflares occur near starspots, which are regions of high magnetic intensity, it suggests itself that enhanced dynamo activity is responsible. During the dynamo process weak initial magnetic fields get enhanced to appreciable values. Enhancement of this effect can come through strong shearing flows in the star's convective layer, which is the case for fast rotating stars. In this sense I investigated the occurrence rate of superflares in dependence of the dimensionless rotation rate, the Rossby number Ro.

There is a convincing connection between the Rossby number and the occurrence rate of superflares. The higher the Rossby number, the more frequent they occur. Even a power law behavior of Ro^{-2} for the frequency is determined (see figure below). For the peak energy I find correlations as well, together with a power law of $Ro^{-1/3}$. All this suggests that an enhanced dynamo is responsible for the occurrence of superflares.



As about half of the stellar systems are binary stars I considered the enhancement of magnetic activity through coupling effects. Coupling can be through gravitational forces, which give rise to tidal forces, and magnetic coupling. By performing simulations of a dynamo in a simplified binary system with tidal effects, I investigated their effect on the magnetic field amplification. It turns out that even for strong coupling there is no significant enhancement of the magnetic field. After this negative result, magnetic coupling effects will be investigated.

Through discussions with various students at the institute we had constructive exchange of ideas. After the two seminars I gave we had various discussions about my past work on dynamo theory and about this project. The students were also involved in this project and contributed with important ideas.

I would like to take this opportunity to thank the GCOE for providing the support that made my research period at Kyoto University possible.