## Activity Report of the NAOJ Visiting Scholar Program

Host Project/Division: <u>太陽観測科学プロジェクト</u> Name of Host Scientist: <u>関井 隆</u>

Name of Visiting Scholar: Allan Sacha BRUN Title: Visiting Professor (Choose the appropriate one) Period: from 17/09/14 to 17/12/16

### I. Report from the visiting scholar

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

#### (Collaborative Research)

With Sekii-san we have developed a suite of codes to solve the acoustic waves equations. We have use a paper by Rast 1999, ApJ as the starting point of our development. The idea is to have a tool to study stereoscopic seismology. To achieve this goal, we first developed in Fortran90 a 1-D code and compared it to published benchmark having or not jump in sound speed that induce reflecting waves. We developed also all the visualizing tools using IDL. Then we worked on a 2-D Cartesian version of the code (x, y), specifically testing various boundary conditions and numerical stability and density (sound speed) stratification. After validating the Cartesian code, we developed the 2-D polar version (r, phi). One difficulty was the periodicity in the phi direction and the need of a special treatment. We got it to work nicely. Then we made several tests and implemented various algorithm for time-stepping (euler, RK2, RK4) and spatial derivatives (2nd order and 4th order finite difference). We then implemented a time varying pulse source to mimic the waves generate by stellar convection. We now have a working code and intend to test how various vantage points along the perimeter will or not allow us to detect through correlation of the time series, possible sound speed variations we will have introduced at a specific depth and longitude. The final goal is to apply this code to full 3-D MHD convection simulation as a post-processing, to generate realistic acoustic signals/

We also worked on solar magnetism and dynamo theory to identify what would be the specific signatures of various type of dynamo if seen from the polar regions. This work is still in progress. Advection of the field by meridional flows is key.

#### (Education)

I have interacted with graduate students, as described in [iii].

(Others)

[ ii ] Any comments on this program

Very nice visiting program. All the NAOJ staff people were very helpful. I really enjoyed my time at NAOJ. I was able to discuss with many top scientists and that has been very useful for my research. Sekii-san was a perfect host and our scientific discussions and collaboration excellent.

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

MHD Workshop at HONGO Campus 7<sup>th</sup> of December 2017: 13:30-13:35 Welcome and start of workshop 13:35-14:10 T. Suzuki "Stellar winds from low-metallicity solar type stars" 14:10-14:45 A.S. Brun "Dynamo and intermittent behavior" 14:45-15:20 Y. Masada "Rossby-number Dependence of Large-scale Dynamo in Turbulent Convection" 15:20-15:55 H. Hotta (2X15min) contributions: Magnetic field effect for breaking Taylor-Proudman state" and "Numerical challenge to cover whole convection zone". Discussion + Coffee Break 35 min 16:30-17:05 N. Yokoi Flow generation and angular-momentum transport by helicity 17:05-17:40 S. Toriumi Observation and Modeling of Flare-productive Active Regions 17:40-18:25 T. Sekii & Y. Hatta (40 min - 2 voices) Asteroseismology of KIC11145123 18:25-19:00 Y. Bekki Effects of Prandtl number on stratified convection with and without rotation Workshop adjourn, and available persons go out for dinner. NAOJ colloquium on 24<sup>th</sup> of November: Star-Planet Interactions and the Dawn of Exo Space Weather ISAS Space Science colloquium on the 13<sup>th</sup> of December: Stellar magnetism, dynamo action and the solarstellar connection Participation to SSP seminar (organizer S. Toriumi) Scientific Discussions with Y. Hatta (NAOJ) and Y. Bekki (UTokyo) on their PhD works Scientific discussions in RIMS with Yamada-san and Takehiro-san at Univ. of Kyoto on turbulent solar-like star convection Participation to Helicity thinkshop hosted by Yokoi-san Discussions with Sakurai-san and Suzuki-san on solar wind theory and 11-yr cycle variations Discussions with Shibata-san on superflares and free energy provided by solar dynamo Visiting Shiota-san at NICT to discuss Space Weather and operational predictions

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 N/A