

# **Report by Dr. Sushil Kumar**

## **Ratu Sir Kamisese Mara Visiting Fellowship 2010-2011**

### **Hosted by the Department of Physics of Otago University**

#### **Introduction**

The Ratu Sir Kamisese Mara Visiting Fellowship was established by the University of Otago in 2004 to honor the memory of Sir Ratu Kamisese Mara, the most prominent leader of Fiji and indeed of the Pacific Region and a graduate of Otago University. Prof. Biman Chand Prasad was the first recipient (inaugural) of this prestigious award in 2007, and I am the second holder of the Fellowship. I undertook my fellowship from 15 January to 14 April 2011, to work with Space Physics Group of the Department of Physics, Otago University, which is one of the most active and productive research groups at international level engaged in investigating the natural environment using Extremely Low Frequency (ELF) and Very Low Frequency (VLF) signals.

#### **Department of Physics, Otago University**

The Department of Physics provided the facilities and administrative support for my three month visit to work with Space Physics Group and in particular in collaboration with Associate Professor Dr. Craig J. Rodger. I had several useful meetings with Dr. Craig J. Rodger and Associate Professor Dr. Neil Thomson on the subionospheric VLF propagation and modeling. During my stay I also visited the undergraduate Physics teaching laboratories running this semester (Sem. I, 2011). I was very happy to see well organized and interesting experiments from first year to third year laboratory space, with these laboratories equipped with data projectors. In the 100-level labs, each table with an experimental set-up on it (about 4 students around the table) had a computer loaded with a power point presentation describing details of the lab running that week – so the computer is used to help inform the student as well as for normal laboratory activities (like plotting and analyzing data). I was most impressed with the management and administration of the Physics course PHSI191 which has about 1400 students. USP is now running four very large generic courses which are compulsory for all USP students.

The discussions with the coordinators of the courses like PHSII191 (as there are a few other even large courses at Otago University) could help different schools, faculties, and USP at large to improve our administration of the recently started 100 level generic courses.

Following is the list of my main research activities;

- Analyzed the SoftPAL data recorded at Suva for unusually long recovery VLF perturbation events and VLF perturbations associated with narrow and wide-angle scatterings.
- Reviewed two research papers from Indian Journal of Radio and Space Physics and Advances in Space Research.
- Contributed to ongoing work on “D-region ionosphere response to the Total Solar Eclipse of 22 July 2009 deduced from VLF tweek observations in the Indian sector”, in collaboration with Indian Institute of Geomagnetism, India, and Stanford University, USA.
- Worked out the operation of LONG WAVE PROPAGATION CODE (LWPC) version 2.1 with the support of Dr. Craig J. Rodger and Dr. Neil Thomson. The work on the modeling of narrowband data recorded at Suva is in progress. The LWPC tool can now be used by USP researchers, adding a new modeling ability to complement the existing data gathering infrastructure.
- The Pico-recorder experiment to record lightning waveform at high sampling rate was installed. Pico-recorder was attached to one of the Space Physics Group’s VLF antennas as a part of *World-Wide Lightning Location Network*, operated by Otago University and University of Washington, USA. The data for about a month has been recorded which will be analyzed in future, as part of a collaborative project.

During my fellowship I was invited by Prof. John Hearnshaw, Department of Physics and Astronomy, Canterbury University, for their departmental seminar series. I presented a seminar on 25 March 2011 entitled “*ELF-VLF Radio waves: Diagnostic Tools to Study Upper Atmosphere*” organized at the Christchurch Astronomical Society, as Canterbury University was closed due the February 2011 earthquake.

## **Other Activities**

- *Pacific Islands Center*: Pacific Islands Center (PIC) actively provides information and academic support to the students of Pacific Island Countries. It was pleasing to meet many of the students during the welcome function. I was happy to chair the opening of the PIC seminar series and have discussions with many of students and staff. I presented a seminar on 14 April 2011 entitled “*Climate Change-Lower and Upper Atmosphere: implications to the South Pacific Region*” organized by the PIC. Upon conversation with PIC students on above occasions, I found that they were very happy and appreciative of center’s support to them. I strongly believe that PIC is doing a wonderful job and needs continuous support from the university. I wish to thank Ms Tofilau Nina Kirifi-Alai, Manager, PIC, for her support and friendship.
- *Pacific Peoples Reference Group*: I attended a meeting on 13 April 2011 with Professor Vernon Squire - Deputy Vice-Chancellor (Academic and International) who is the Convener of the Pacific Peoples Reference Group along with Ms Tofilau Nina Kirifi-Alai - the manager of the Pacific Islands Centre. There has been a significant increase in the number of students from the Pacific Island Countries in the recent years. I was impressed with the plans and efforts of Professor Vernon’s office in developing the Pacific Strategic Framework and Research Protocol of the Otago University.

## **Implications of Visiting Fellowship**

VLF is one of the most cost-effective radio wave techniques that has been used successfully to explore lower part of the ionosphere. VLF waves received from existing communication transmitters after propagating in the Earth-ionosphere waveguide enable us to study the morphology of D-region of the ionosphere, which is poorly understood. The Physics section of the School of Engineering and Physics at USP is running a third year undergraduate course on Electrical Communication and Instrumentation which includes a part on electromagnetic wave propagation. The Physics section also offers a postgraduate course on Radio Wave Propagation and conducts the research in the area of communications and Space Physics. The output of the work carried out and further understanding developed of the subject during this fellowship shall enable us teach and

conduct lab components better on the topics related to the propagational features of VLF/ELF signals in the Earth-ionosphere waveguide at low latitudes in the South Pacific Region. It will certainly enhance our research area leading to Masters and PhD students.

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Overall my stay at Department of Physics, Otago University, was very productive and enjoyable.

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