SCIENTIFIC REPORT

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HOST RESEARCHER: DR. CARLOS GONZÁLEZ-FERNÁNDEZ (INSTITUTE OF ASTRONOMY, CAMBRIDGE, U.K.) [cgonzal@ast.cam.ac.uk]

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1 Purpose of the visit

The aim of the visit was working with Dr. Carlos González-Fernández and his collaborators at the Institute of Astronomy in Cambridge, in the field of Galactic structure, kinematics and dynamics to develop and plan some present and future lines of research.

Carlos and I have colaborated and produced several papers in the last years about Galactic structure, and our intention now was exploring together new ideas to produce new papers. Dr. Mike Irwin (from Institute of Astronomy, Cambridge), Dr. Carlos González-Fernández and I have also prepared last April a proposal of a project for a PhD student in the frame of international IAC-grants (Tenerife, Spain), a project which will be offered to students in 2014. The title of the project is: "Chemistry and Dynamics of the Inner Milky Way".

2 Description of the work carried out during the visit

Several tasks were carried out in the Institute of Astronomy of Cambridge:

- We have discussed future observations with infrared spectrographs in very large telescopes: VLT with the instrument KMOS in the south and GRANTECAN with the instrument EMIR (coming soon) in the north, for the stellar population associated to the long bar, in order to derive kinematical and chemical information which allows us to understand the distinction with the population of the bulge. The proposal will be written and submitted within ESO and IAC telescope time applications during next semester. This is part of the PhD student project mentioned above, but it will be carried out even if a PhD student is not assigned.

- Carlos and his team in Cambridge (Mike Irwin, Vasily Belokurov and the PhD student Iulia T. Simion) have shown me their work on bulge morphology with VISTA-VVV data and we have been discussing on the topic.

- A talk at Institute of Astronomy was offered: on May 9th, "Canis Major overdensity and Monoceros Ring explained in terms of pure Milky Way structure".

- Prof. Wyn Evans (Inst. of Astron., Cambridge; working in GAIA) was interested in some discussions on my talk about the kinematics of Galactic warp and the predictions of the theoretical models for future GAIA observations, so I gave him a copy of my paper in preparation about vertical velocities with proper motions which will be read by him to receive some comments.

- The main work was the analysis of data and discussions carried out by Carlos González-Fernández and I. The visit here in Cambridge has allowed us to work together during two weeks in many topics, an interaction which would not be possible or it would go very slow if we worked separately in our respective institutes. There have been five different aspects of morphology and kinematic of the Milky Way studied during these days:

    1. Morphology of the bulge. We investigated the possibility to get the double peak with Red Clumps for the X-shaped bulge. We downloaded SDSS photometric data in the only available region ($\ell \approx 9^\circ$, $b \approx 12^\circ$) to investigate it.
    2. Morphology of the disc. The flare (variable scaleheight) of the disc was claimed in my talk about Monoceros to be the main reason for the overdensity known as Monoceros ring, and this gets a good fit of the Galactic stellar counts of SDSS in low extinction regions at $8^\circ < |b| < 23^\circ$ at $R \leq 30$ kpc. Some discussions about it made us think that we could get further evidences of the flare in the own plane if we use a near-infrared survey and a different standard candle from red clumps, which only allow to reach $R \leq 16$ kpc. We decided to investigate the IR C stars in 2MASS survey.
    3. Kinematics of the long bar. We used proper motions of PPMXL and radial motions of APOGEE in a selected sample of stars which are classified as red clumps, or stars from RAVE with spectrophotometric paralaxes. Our intention was finding evidences of non-circular orbits where the long bar is supposed to exist.
    4. Kinematics of the disc. The same thing as before is done in the disc up at $R \leq 14$ kpc.

5. We also discussed the exploitation of future data of GAIA, in particular about the distances derived by parallaxes, radial velocities and proper motions, which will allow us to continue our research of the outer disc improving our present applications.

3 Description of the main results obtained

Apart from the chance to know other people's work and to establish some professional contacts, the main result of my visit was the scientific work Carlos and I have carried out. About the previous five points, we got the following results:

1. We could not see the double peak expected in a X-shaped bulge in SDSS data. Possibly we will have to explore lower $|b|$. We keep this as a pending work for the future, possibly with OGLE-IV data when they become public or contacting the OGLE team for that.

2. We were succesful to observe the imprint of the flare with IR-C stars in 2MASS. Further detailed analysis is still pending, related with the contamination of other populations, and we want to analyze these stars in the AKARI mid-infrared all-sky survey. We expect anyway that we will be able to write a paper about this topic within some months.

3. PPMXL proper motions are not useful for our task since their error bars are too large, but AGOGEE radial velocities were more appropriate. For RAVE we could not see an advantage with respect to the deeper APOGEE. Although some signal is obtained, we require still further data in the long bar area to take any conclusion.

4. Also for the disc, APOGEE radial velocities were shown to be a much better tool. We explored the eccentricity of orbits or radial migration as a way to explain some tiny but significant detection of average radial velocity in the outer disc stars.

5. We are prepared to make use of GAIA data to extract some unknown kinematical features of our Galaxy. The ideas we are working now with the proper motions of PPMXL and radial velocities of APOGEE or RAVE will be further applied when GAIA data become available.

4 Future collaborations with host institution

If a PhD student chooses our common project, we will carry a colaboration for the next 3-4 years with it. In any case, the collaboration with Carlos will continue for a long time, and with the rest of Cambridge team on Galactic structure, VISTA-VVV, GAIA,... since we will work together in exploitation of those surveys and we will apply together telescope time.

5 Projected publications resulting or to result from the grant

We expect to produce two papers, within one year more or less. ESF will be acknowledged in these papers. Other ideas which were produced during my present visit in Cambridge might also lead to future works with future publications, but for a longer term of more than one year. If something is obtained with the developments of these ideas, ESF will also be acknowledged.