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The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus

Edited by

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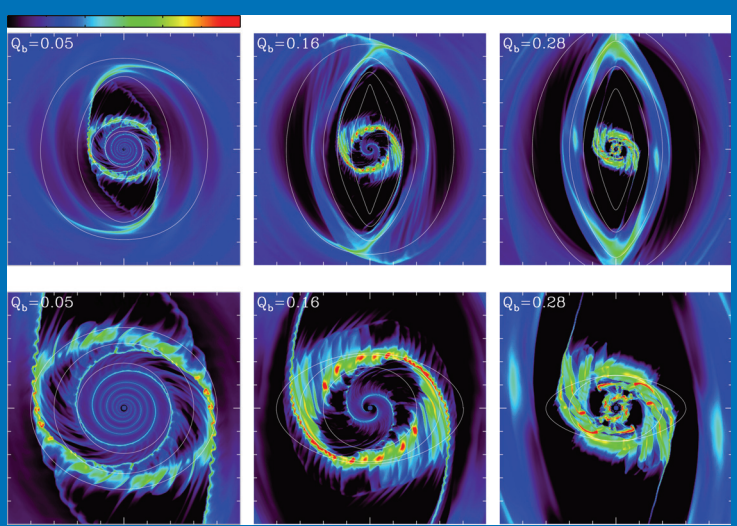

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THE GALACTIC CENTER: FEEDING AND FEEDBACK IN A NORMAL GALACTIC NUCLEUS

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COVER ILLUSTRATION:

Numerical simulations of the gas surface density in the Galactic center central bar. See symposium contribution at page 43.

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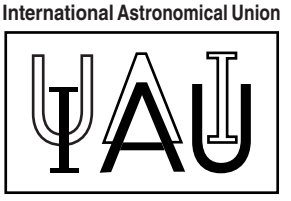

THE GALACTIC CENTER: FEEDING AND FEEDBACK IN A NORMAL GALACTIC NUCLEUS

PROCEEDINGS OF THE 303rd SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN SANTA FE, NM, USA, SEPTEMBER 30 – OCTOBER 4, 2013

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Preface

Scientists are currently are at a crossroads in Galactic center research and in research on the nuclear regions of many similar nearby galaxies. Many recent large-scale surveys and wide-field studies of this unique and unusual region of the Galaxy have been made (using *Hubble*, *Chandra*, *Spitzer*, *Fermi*, *Planck*, *Herschel*, and numerous ground based observatories). Such surveys have provided us with multi-wavelength views of the stellar and interstellar environment in the central few hundred parsecs. Additional surveys filling in the gaps in the electromagnetic spectrum are underway or being planned (VLA, ALMA, SOFIA, etc.). At the same time, unprecedented high angular resolution views of the very central nuclear region are being constructed using the largest and most powerful telescopes on the ground (VLT-I, Keck, VLBA, EHT) providing us more details than ever before on the stellar population and the immediate environment of the 4 million solar mass black hole, Sgr A*.

Many of the large- and small-scale phenomena observed in galactic nuclei are due to the influx of gas from the outer parts of a galaxy and the feedback of energetic processes in the interstellar environment. In the Milky Way, for example, this process leads to a situation where the gas that resides in the Galactic center represents about 10% of the gas involved in star formation in the Galaxy, but it only occurs in about 0.001% of the Galaxy's volume. It is likely that this gas has funneled to its present location during episodes in the lifetime of our Galaxy's bar. The gas in the Galactic center is characterized by very high densities and turbulent conditions. The multi-phase gas is subject to strong and weak shocks as well as heating via dust, UV photons, cosmic rays and cloud-cloud collisions, all embedded within a strong and widespread magnetic field. Understanding the details of the interplay between stars and the interstellar medium and the role of cosmic rays in heating and interacting with the interstellar medium is crucial to our understanding of nuclear processes in many normal galaxies and in the cores of very distant galaxies.

The International Astronomical Union (IAU) symposium entitled, "The Galactic Center: Feeding and Feedback in a Normal Galactic Nucleus" was held in Santa Fe, New Mexico, USA from 2013 September 30 through October 4 to address the astrophysics of galactic nuclei with a focus on our Milky Way. This symposium was the latest in the long series of regular international workshops and symposia that are put together by members of the Galactic center research community. One of the first symposia on the Galactic center was held in 1989 in Los Angeles, California, USA (IAU 136). More recently, the IAU has sponsored a symposium on the Galactic center and nearby nuclei (IAU 184) in 1997 (Kyoto, Japan), and the community has put together meetings in 1996 (Chile), 1998 (Tucson, Arizona, USA), 2002 (Kona, Hawaii, USA), 2006 (Bad Honnef, Germany) and 2009 (Shanghai, China). A priority at all of these meetings, including this IAU 303, has been to create an atmosphere of international collaboration and a meeting in which ample time is reserved for productive discussions.

The IAU 303 symposium was very well attended by more than 160 participants from many continents. The 65 talks included numerous postdocs and graduate student speakers and featured 25% female participants. This is perhaps the largest gathering of scientists in the series of Galactic center workshops over the last 20 years. Because of the large numbers, we had 82 poster presentations. Poster presenters were additionally given an opportunity to present a short 'highlight' of their work. These "poster previews" worked

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very well and went very smoothly. Conversations around the poster boards persisted during the entire week.

Scientific progress on understanding the role of interstellar gas in the Galactic center was especially noticeable by many of the results featuring recent, high angular resolution, multi-wavelength large scale surveys of molecular gas in the central molecular and dust zones of our Galaxy as well as a number of nearby Milky Way analogs. The presenters made it clear that such studies are helping elucidate the role of gas in the Galactic center and also the role of AGN feedback in other galaxies. Up to date studies of stellar populations revealed the latest results on the orbits around Sgr A*, as well as the discovery of a dusty object named G2/DSO, whose origin and exact nature was the focus of several talks and debate. The periastron of its orbit is predicted for Spring 2014, and may result in enhanced accretion onto the supermassive black hole or interact with the existing flow itself. Continued observations are planned of this possible event at all wavelengths. A variety of theoretical models were proposed to explain the G2/DSO event, as well as the general accretion and jet formation in the vicinity of Sgr A*. The large-scale γ-ray emission (Fermi Bubble) was discussed in the context of possible past and current energetic activity in the Galactic center and the role of the magnetic field was emphasized. Future observing opportunities were discussed, including monitoring G2 and Sgr A* across the wavelengths and at very high angular resolution (i.e., the Event Horizon Telescope).

The local organization could not have worked out more smoothly. The weather was perfect (warm and sunny most days) and the location, the Santa Fe Plaza, allowed participants have some cultural experiences after attending the scientific sessions. On Monday evening, we gathered for an opening reception at the New Mexico Museum of Art and on Wednesday evening the symposium banquet was held at the famous Coyote Café in downtown Santa Fe. On the Sunday proceeding the workshop, a tour of the Very Large Array (VLA) was attended by about 40 participants; unfortunately a number of participants had to miss it due a canceled flight, and the week after due to the US Government shut down. The tour included VLA antenna climbs as well as trips to the visitor center and control room. At the VLA site, the University of New Mexico (UNM) proudly presented the first station of the Long Wavelength Array (LWA).

The evening of the banquet Professor James Moran was honored as the 2013 recipient of the Grote Reber medal. This medal is awarded annually to persons that have made significant and innovative contributions to radio astronomy. Moran is the Donald H. Menzel Professor of Astrophysics at Harvard University and a Senior Radio Astronomer at the Smithsonian Astrophysical Observatory (SAO), where he has spent his entire career. Moran was recognized with the Reber Medal for his pioneering work in the development and application of spectroscopic Very Long Baseline Interferometry. He has also contributed to the understanding of the intrinsic size of the radio source associated with Sgr A* by using the VLBA and more recently, the Submillimeter Array (SMA).

Of course an event like this would not have been possible without the generous support from our sponsors, volunteers and host institutions. The organizers greatly acknowledge financial support from the International Astronomical Union (IAU), the National Radio Astronomy Observatory (NRAO), the University of New Mexico (UNM), the New Mexico Institute of Mining and Technology (NMT), the North-American ALMA Science Center (NAASC), Associated Universities Inc. (AUI), and Springer.com publishers. In particular, for the success of the meeting we hereby also specifically like to thank the session chairs who did a wonderful job in leading the discussion sections, the NMT and UNM students and other volunteers running around helping with microphones, directions, etc., and the professional staff at NRAO and La Fonda.

We hope that these proceedings will serve as a review of a very stimulating meeting and will inspire future work in this exciting research area.

Cornelia Lang, Jürgen Ott and *Loránt Sjouwerman*, co-chairs LOC

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Amy Mioduszewski, National Radio Astronomy Observatory
Jürgen Ott (co-chair), National Radio Astronomy Observatory
Loránt Sjouwerman (co-chair), National Radio Astronomy Observatory
Greg Taylor, University of New Mexico

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The SOC and LOC would also like to thank the individual session chairs and the helping hands of the NMT and UNM students, NRAO staff and other local volunteers as well as the friendly and helpful staff of the La Fonda on the Plaza.

The Local Organizing Committee operated under the auspices of the National Radio Astronomy Observatory, Socorro NM, USA.

CONFERENCE PHOTOGRAPH

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