

REPORT ON THE RADIO.NET3 NETWORKING ACTIVITY

TITLE: **RADIO HALOS OF GALAXIES
A CHANG-ES CONSORTIUM WORKSHOP**

DATE: *1-5 JULY 2013* **TIME:** (WHOLE DAY)

LOCATION: *LEIDEN, THE NETHERLANDS*

MEETING WEBPAGE <http://tinyurl.com/radiohalos>

HOST INSTITUTE: *LORENTZ CENTER (@SNELLIUS)*

PARTICIPANTS NO: *25 REGISTERED / 24 ATTENDED*

REPORT:

1. Agenda of the meeting

Monday, 1 July 2013

Theme: Disk-Halo Science and Our Science Goals

Moderator: Bob Benjamin (University of Wisconsin – Whitewater, USA)

09:00 – 10:00 Arrival, registration

10:00 – 10:15 Welcome by Mieke Schutte, manager of Lorentz Center

10:15 – 10:30 Overview, Status, and Meeting Focus — Judith Irwin (Queen's University, CANADA)

10:30 – 11:15 A Multiwavelength View of the Disk-Halo Interface in Spiral Galaxies — Ralf-Jürgen Dettmar (Ruhr Universität Bochum, GERMANY)

11:15 – 12:00 The FIR-Radio Continuum Relation — Eric Murphy (Caltech, USA)

12:00 – 13:30 Lunch/informal discussions

Moderator: Troy Porter (Stanford, USA)

13:30 – 14:15 Lagging Extra-planar Gas & the HALOGAS Project — George Heald (ASTRON, THE NETHERLANDS)

14:15 – 15:00 Diffuse Ionized Gas and the Disk-Halo Connection — Rene Walterbos (New Mexico State University, USA)

15:00 – 15:30 Coffee Break

15:30 – 16:15 X-raying the Galactic Disk/Halo Interaction — Dan Wang (UMass – Amherst, USA)

16:15 – 17:00 Chandra Survey of Nearby Edge-on Galaxies — Jiangtao Li (CEA-Saclay, FRANCE)

17:00 – Wine & Cheese party

Tuesday, 2 July 2013

Theme: CHANG-ES Results/Technical

Moderator: Marita Krause (MPIfR, GERMANY)

09:00 – 09:45 Rotation Measure Synthesis — George Heald (ASTRON, THE NETHERLANDS)

09:45 – 10:05 NGC 891 & NGC4565 — Philip Schmidt (MPIfR, GERMANY)

10:05 – 10:25 NGC 4631 — Silvia Carolina Mora (MPIfR, GERMANY)

10:25 – 11:00 Coffee Break

11:00 – 11:20 NGC 5907, CHANG-ES + Westerbork Data — Arpad Miskolczi (Ruhr Universität Bochum, GERMANY)

11:20 – 11:40 NGC 3735 — Theresa Wiegert (Queen's University, CANADA)

11:40 – 12:00 NGC 4666 — Yelena Stein (Ruhr Universität Bochum, GERMANY)

12:00 – 12:20 NGC 3079 — Carlos Sotomayor (Ruhr Universität Bochum, GERMANY)

12:20 – 14:00 Lunch

Moderator: Jayanne English (U. Manitoba, CANADA)

14:00 – 14:20 Group Photo

14:20 – 14:40 What's New, Interesting or Emerging? — Judith Irwin (Queen's University, CANADA)

14:40 – 15:30 Formation/organization of working groups

15:30 – 16:00 Coffee Break

16:00 – 17:30 Break-out sessions of working groups

Wednesday, 3 July 2013

Theme: Technical/Scientific

Moderator: Ralf-Jürgen Dettmar (Ruhr Universität Bochum, GERMANY)

09:00 – 09:45 Reducing Data using CASA — Theresa Wiegert (Queen's University, CANADA)

09:45 – 10:10 CHANG-ES & the GBT: Current Status and Update — Amanda Kepley (NRAO, USA)

10:10 – 10:35 CHANG-ES & the GBT: Data Combination with CASA — Megan Johnson (NRAO, USA)

10:35 – 11:00 Coffee Break
11:00 – 11:45 The Galactic Cosmic-ray and Multiwavelength Context — Andrew Strong (MPA, GERMANY)
11:45 – 12:30 Spectral Index Maps and Thermal/Non-thermal Separation — Judith Irwin (Queen's University, CANADA)
12:30 – 12:45 Determining CRE Outflow Speeds from Halo Synchrotron Emission — Rainer Beck (MPIfR, GERMANY)
12:45 – 14:00 Lunch
14:00 – 17:30 Hands-on Data Reduction Session — Theresa Wiegert (Queen's University, CANADA) + assistants
17:30 Departure bus for boat trip

Thursday, 4 July 2013

Theme: Magnetic Fields and Theory

Moderator: Rainer Beck (MPIfR, GERMANY)

09:00 – 10:00 Invited Talk: Cosmic-ray Driven Dynamo and Winds in Disk Galaxies — Michal Hanasz (Nicolaus Copernicus University, Torun, POLAND) (Introduced by Andy Strong, MPA, GERMANY)

10:00 – 10:45 Magnetic Fields in Edge-on Galaxies — Marita Krause (MPIfR, GERMANY)

10:45 – 11:15 Coffee Break

11:15 – 12:00 Disk-Halo Magnetic Interactions — Richard Henriksen (Queen's University, CANADA)

12:00 – 14:00 Lunch

Moderator: Rainer Beck (MPIfR, GERMANY)

14:00 – 14:45 Simulations of Vertical Structure in a Magnetized ISM — Bob Benjamin (University of Wisconsin – Whitewater, USA)

Theme: Maximizing the Science

Moderators: Rene Walterbos (New Mexico State University, USA), Richard Henriksen (Queen's University, CANADA)

14:45 – 17:30 Discussions: what can we do with individual galaxies? What can we do with the entire set? Prioritizing the data reduction and maximizing the science output. Identification of near-term, mid-term and far-term goals. Proposed NSF Grant (Rand (University of New Mexico, USA) via Skype).

Friday, 5 July 2013

Theme: Science/Post-Processing/Organizational

Moderator: Dan Wang (UMass Amherst, USA)

09:00 – 09:45 Visualization as a Tool for Disk-Halo Discovery – Jayanne English (University of Manitoba, CANADA)

09:45 – 10:30 Discussions

10:30 – 11:00 Coffee Break

Moderator: Judith Irwin (Queen's University, CANADA)

11:00 – 12:30 Discussions: Policies & Plans; Public Release of Data Products, formats, & quality control; Timeline for Scientific Publications, Wrap-up and Clarity on Activities for each member.

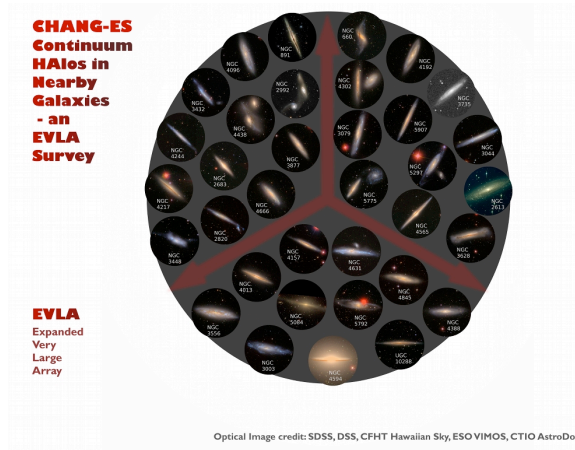
12:30 – 14:00 Lunch

14:00 – 15:00 Steering Committee Meeting

2. Scientific Summary

Radio astronomy is currently undergoing dramatic developments. Its post-world war II infancy and growth owe much to the leadership and vision of radio astronomers such as Jan Oort who made Leiden his home. Some of the most important technical accomplishments in the field continue to be based in the Netherlands, including the Low Frequency Array (LOFAR), designed by ASTRON (the Netherlands Institute for Radio Astronomy) and the focal plane array upgrade to the Westerbork Synthesis Radio Telescope (WSRT). It is therefore appropriate that our consortium, some of whom are Dutch and/or involved in Dutch projects, sought to hold a pivotal radio astronomy workshop at the Lorentz Center @ Snellius in Leiden.

The Karl G. Jansky Very Large Array (also known as the Expanded VLA or EVLA, located near Socorro, New Mexico, in the USA) is the world's premiere 'all-purpose' radio telescope operating at frequencies complementary to those of LOFAR. This interferometer is now undergoing a major upgrade in sensitivity and in broad-band capability, largely enabled by the Canadian-built Wideband Interferometric Digital ARchitecture (WIDAR) correlator, which is the 'brains' of the array. Our international consortium that represents six nations has received 405 hours of observing time on the EVLA during its commissioning period. The project is called Continuum Halos in Nearby Galaxies – an EVLA Survey (CHANG-ES) and has observed 35 edge-on galaxies (Fig. 1, showing optical images of the galaxies) in the radio continuum at both 6 GHz and 1.5 GHz with wide frequency coverage (2 GHz and 500 MHz, respectively) and in full polarization. The observing, which began in spring, 2011, was carried out in three different EVLA array configurations.



The science goals for CHANG-ES include probing the origin of and physical conditions in galaxy halos, searching for clues on lagging halos, understanding cosmic ray transport and wind speed, mapping magnetic fields in galaxy disks and halos, extending the far-infrared radio continuum relation into halos, connecting radio halos with gamma-ray data, and developing a repository of publicly-accessible 'legacy-value' radio images for future study. A complete description of the science can be found in Irwin et al. (2012, AJ, 144, 43).

The timing for the workshop was also key. All EVLA data are now in hand and data reductions have been completed for some, but not all, galaxies. Some data have been published; for example (Irwin et al. 2012a, 2012b: AJ, 144, 43 & 44). However, the full potential of the CHANG-ES project has not yet been realized. The intention of our workshop was to share new results and to engage more members of our group in the data reduction process.

Broad band continuum data reduction is challenging, but thanks to 3-month tenure in Socorro by both Irwin (Queen's University, CANADA) and Saikia (NCRA, Pune, INDIA) in Spring of 2011, an 8-month stay by post-doctoral fellow, Wiegert (Queen's University, CANADA), over Fall/Winter, 2011/12, and extended visits by PhD students who are part of the consortium, we have a good understanding of the subtleties involved in reducing data. We have been working closely with EVLA staff as well to help improve their algorithms. The Lorentz Center workshop allowed us to share our collective knowledge on data reduction with the entire consortium via a successful hands-on session during the workshop.

It was also important for us to have a face-to-face meeting, rather than trying to communicate from a distance. Although our group has communicated via email, Skype and wiki pages, we had not yet had a chance for a free-flow of ideas and also to discuss how our science goals can be addressed in the specific and practical ways that allow completion of projects. The collaboration meeting allowed natural liaisons between sub-groups and clarified how science goals will be managed. Our group represents a significant fraction of the world's expertise in disk-halo physics. It also includes theoreticians and experts in wavebands other than the radio. Some of us had never met face-to-face before.

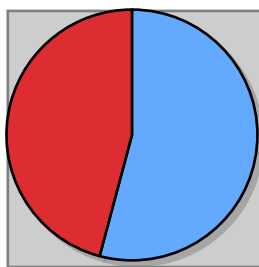
By the end of the meeting, we hoped to have accomplished the following: a) enable the members of the consortium to become comfortable with each other so that scientific ideas related to the CHANG-ES

project can be freely and openly exchanged, b) provide hands-on experience and guidance for those who wish to pursue data reduction further, c) share new results and discuss the pursuit of new science avenues as they become apparent, d) prioritize our science goals (and galaxies) so as to maximize the scientific output of the data in a timely fashion (when and by whom), and e) decide how to best present the images at the formal end of the project as a 'legacy' data set, as promised when the EVLA proposal was submitted.

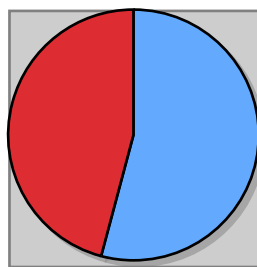
During the workshop *all of goals a) through d) were completely met*. We have a clear plan for reducing the remaining data sets, with priorities set and clarity as to who will work on which data set. The hands-on workshop was particularly important in this regard. The opportunity to meet and share different aspects of the science was particularly important. Note that goal e) was discussed but requires revisiting since we need to advance further in our data reduction before this goal is fully realized.

An example of a current public image made from CHANG-ES data is shown on the workshop poster visible at [HTTP://TINYURL.COM/RADIOHALOS](http://tinyurl.com/radiohalos).

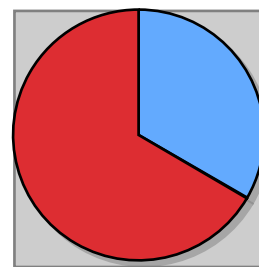
The attending participants were well mixed. There were 13 from Europe and 11 from North America (both Canada and US). In terms of career stage, there were 11 postdocs and students, and 13 senior researchers. The gender balance was 8 (33%) female participants and 16 males.



■ Europe ■ North America



■ Senior ■ Early career



■ Female ■ Male

A conference photo is included below.



3. Attendance list (incl. participant names, affiliation and country) signed by the participants and confirmed by the organizer

Attached

4. Financial Report / RadioNet3 contribution

The final budget is included below. The RadioNet contribution, 3500 Euro, was used for accommodation and travel support, with a strong emphasis toward supporting the participation of students. For example, all student travel and accommodation costs were 100% covered (see above list for names). Contributions towards travel/accommodations were made for all post-docs. In addition contributions towards travel and/or accommodations were also made for more senior individuals without sufficient support to attend.

Lorentz Center funding	3500
RadioNet funding (*)	3500
Queen's University funding	730
Accommodation support	-5744
Travel support	-1300
Balance	686

(*) The participants who received RadioNet support are:

Megan Johnson	(NRAO, Green Bank, United States) [Post-Doc]
Amanda Kepley	(NRAO, Green Bank, WV, United States)[Post-Doc]
Jiang-Tao Li	(CEA-Saclay, Gif sur Yvette, France) [Post-Doc]
Arpad Miskolczi	(Ruhr Universität Bochum, Germany) [PhD]
Silvia Carolina Mora Partiarroyo	(MPIfR, Bonn, Germany) [PhD]
Philip Schmidt	(MPIfR, Bonn, Germany) [PhD]

Carlos Sotomayor
Yelena Stein
Marek Wezgowiec
Theresa Wiegert

(Ruhr Universität Bochum, Germany) [PhD]
(Ruhr Universität Bochum, Germany) [PhD]
(Ruhr Universität Bochum, Germany) [Post-Doc]
(Queen's University, Kingston, ON, Canada) [Post-Doc]

We request that the RadioNet contribution to be paid directly to the Lorentz Center, who has kindly managed the financial logistics for the meeting.

5. Conference Proceedings and Web page

We did not produce conference proceedings. The survey website is visible at this URL:

<http://www.astro.queensu.ca/~irwin/CHANGES/>

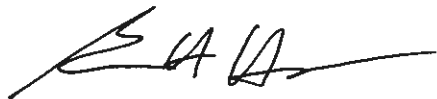
Presentations from our meeting are currently posted on the consortium wiki site. However, since many presentations contain proprietary images, they are not being made public at this time.

3. Attendance list (incl. participant names, affiliation and country) signed by the participants and confirmed by the organizer

In case of heavy burden with collecting all participant signatures, an attendance list confirmed only by the organizer could be accepted

We were unaware that we needed signatures from the participants, and it would be quite difficult to collect them now. Therefore we provide here the full list of registered participants, along with the signature of one of the organizers, and hope that this will be sufficient.

Rainer Beck	(MPIfR, Bonn, Germany)
Robert Benjamin	(University of Wisconsin - Whitewater, United States)
Ralf-Juergen Dettmar	(Ruhr Universität Bochum, Germany)
Jayanne English	(University of Manitoba, Winnipeg, Canada)
Michal Hanasz	(Nicolaus Copernicus University, Torun, Poland) [Invited Talk]
George Heald	(ASTRON, Dwingeloo, Netherlands)
Richard Henriksen	(Queen's University, Kingston, Canada)
Judith Irwin	(Queen's University, Kingston, Canada)
Megan Johnson	(NRAO, Green Bank, United States) [Post-Doc]
Amanda Kepley	(NRAO, Green Bank, WV, United States)[Post-Doc]
Marita Krause	(MPIfR, Bonn, Germany)
Jiang-Tao Li	(CEA-Saclay, Gif sur Yvette, France) [Post-Doc]
Arpad Miskolczi	(Ruhr Universität Bochum, Germany) [PhD]
Silvia Carolina Mora Partiarroyo	(MPIfR, Bonn, Germany) [PhD]
Eric Murphy	(Caltech, Pasadena, United States)
Troy Porter	(Stanford, United States)
Dhruba Jyoti Saikia	(NCRA, Guwahati, India)
Philip Schmidt	(MPIfR, Bonn, Germany) [PhD]
Carlos Sotomayor	(Ruhr Universität Bochum, Germany) [PhD]
Yelena Stein	(Ruhr Universität Bochum, Germany) [PhD]
Andy Strong	(MPA, Garching, Germany)
Rene Walterbos	(University of New Mexico, Las Cruces, United States)
Q. Daniel Wang	(UMass, Amherst, United States)
Marek Wezgowiec	(Ruhr Universität Bochum, Germany) [Post-Doc]
Theresa Wiegert	(Queen's University, Kingston, ON, Canada) [Post-Doc]



Signed, George Heald

From this participant list, only one registered participant (Saikia) was unable to attend due to other obligations.