The Canadian Initiative for Radio Astronomy Data Analysis

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with **Erik Rosolowsky**, Stefi Baum, Vicky Kaspi, Chris O'Dea, Ue-Li Pen, Kris Sigurdson, Greg Sivakoff, Kristine Spekkens, Ingrid Stairs, Claire Chandler, Shami Chatterjee, Séverin Gaudet, JJ Kavelaars, Mark Lacy, Tom Landecker, Casey Law, Steve Myers, Larry Rudnick, Russ Taylor, Michael Wise, and the CIRADA team

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VLA SKY SURVEY

Dunlap Institute for Astronomy & Astrophysics

UNIVERSITY OF TORONTO

INNOVATION.CA

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Upcoming Surveys and Data Products

- Very Large Array Sky Survey (VLASS): ~1 PB
  - 80% of sky, 2-4 GHz, ~3” resolution
  - 3 epochs, 2017-2024
  - continuum images, polarimetry, time-domain
- CHIME: ~17 PB
  - 70% of sky, 400-800 MHz, ~15’ resolution
  - commensal surveys for transients, polarisation, pulsar search, HI absorption, CMB foregrounds
- ASKAP POSSUM & WALLABY: ~1 PB
  - 75% of sky, 1.1-1.4 GHz, ~10” resolution
  - cosmic magnetism and extragalactic HI
- Basic Data Products (BDPs)
  - raw data, images, postage stamps, coarse cubes, source catalogues
  - automated standard pipeline
  - produced by observatory
  - not real-time
  - useful for simple science applications

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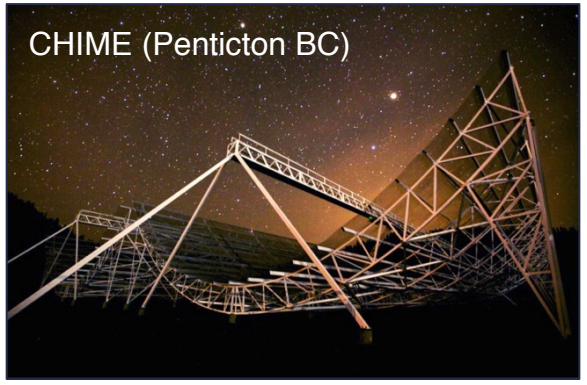
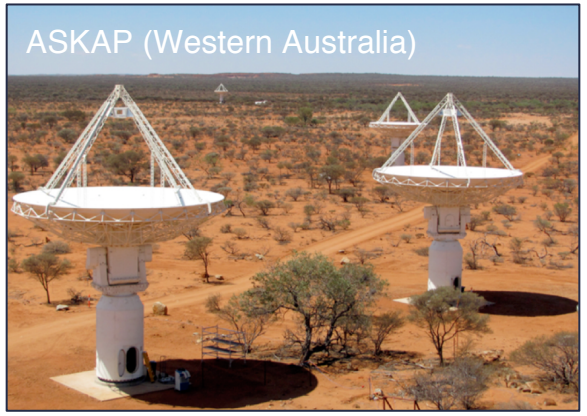
NRAO/AUI/NSF



CHIME



Ant Schinckel

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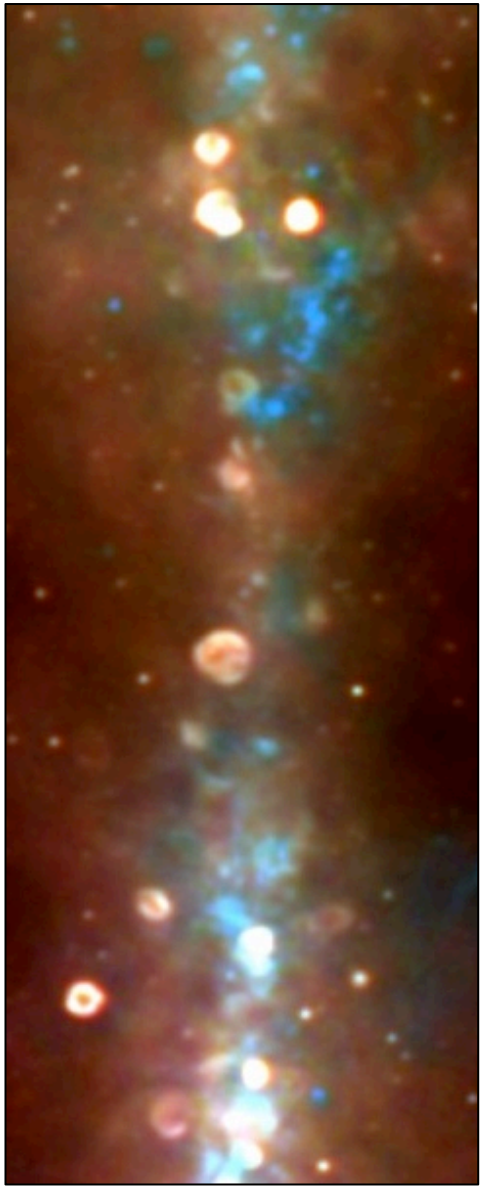
CANADIAN INITIATIVE FOR RADIO ASTRONOMY DATA ANALYSIS

- **Canadian Initiative for Radio Astronomy Data Analysis** (cirada.ca)
  - enhanced data products (EDPs) for VLASS, CHIME and ASKAP surveys
  - advanced re-processing of raw data
  - unified processing software stack
  - cross-matches, advanced analytics, visualisation
  - long-term archiving and data access
  - ***enables full science return from major Canadian science & instrumentation programs***
- Administrative structure
  - CFI Innovation Fund 2017: $10.6M
  - five-year program, commenced April 2018
  - PI: Bryan Gaensler ; Deputy PI: Erik Rosolowsky
  - six Canadian universities: Toronto, Alberta, McGill, Queen's, UBC, Manitoba
  - plus NRC/CADC, Compute Canada, NRAO, ASTRON, IDIA, Cornell, Berkeley, Minnesota



Hindson et al. & Johnston-Hollitt et al.

CIRADA Activities & Products (I)

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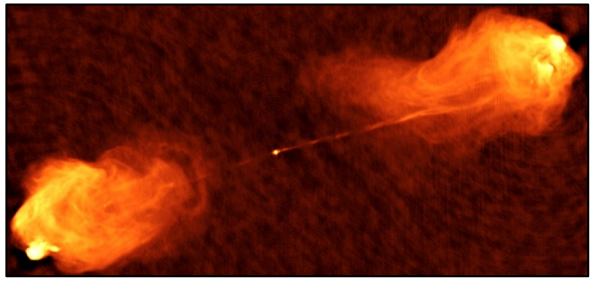
- Pre-processing and storage
  - VLASS : real-time millisecond imaging
  - CHIME : Fourier transform, de-dispersion
  - CHIME : 1 kHz channelization
  - 10 PB of storage at Compute Canada and at the CHIME site in Penticton

- Enhanced data products
  - **Advanced continuum** (VLASS, CHIME)
  - **Transients** (VLASS, CHIME)
  - **Polarimetry** (VLASS, CHIME, ASKAP)
  - **Pulsars** (CHIME)
  - **HI absorption** (CHIME)
  - **HI emission** (ASKAP)



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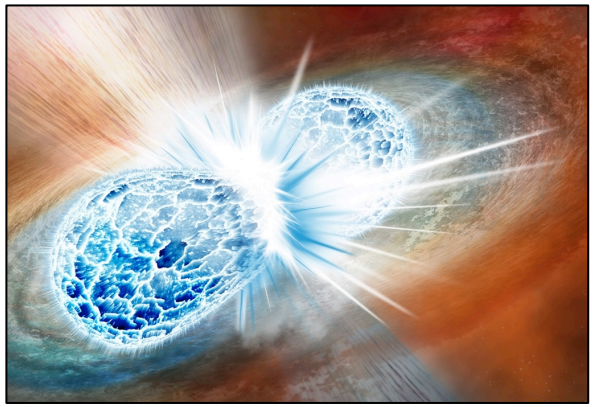
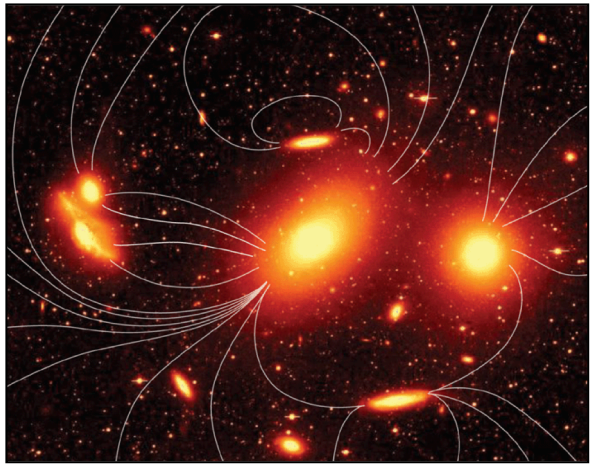


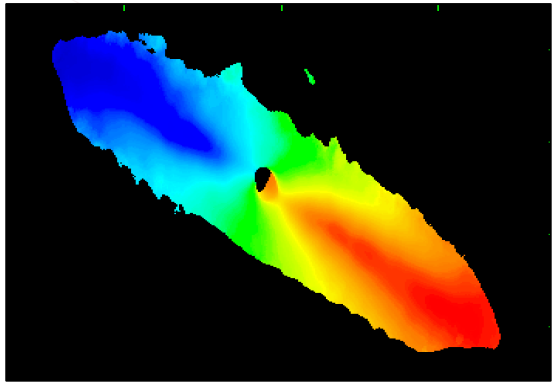
Robin Dienel / Carnegie



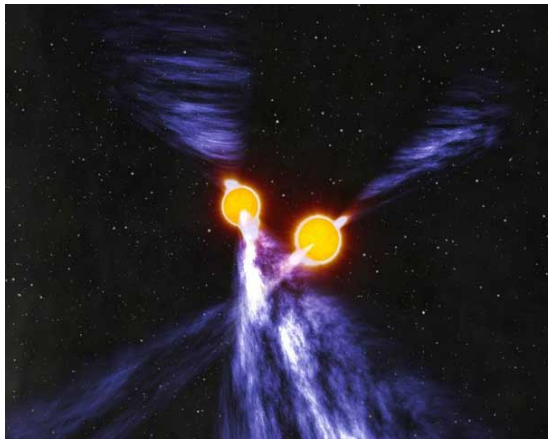
Mihos / Huey / Science

CIRADA Activities & Products (II)

- Unified processing software stack
  - coordinated by project-wide lead developer
  - staged public releases
  - able to operate in multiple environments
- Cross-matching and accessibility
  - multi-wavelength cross-matching
  - high-performance distributed queries
  - Bayesian source classification
  - remote visualisation solutions
- Long-term archiving by CADC
  - indefinite access to enhanced data products
  - CANFAR customisations to enable software stack
  - custom query interface
  - long-term maintenance of interfaces and data formats



Koribalski et al.



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Cassam-Chenaï et al. (2008)

CIRADA and VLASS

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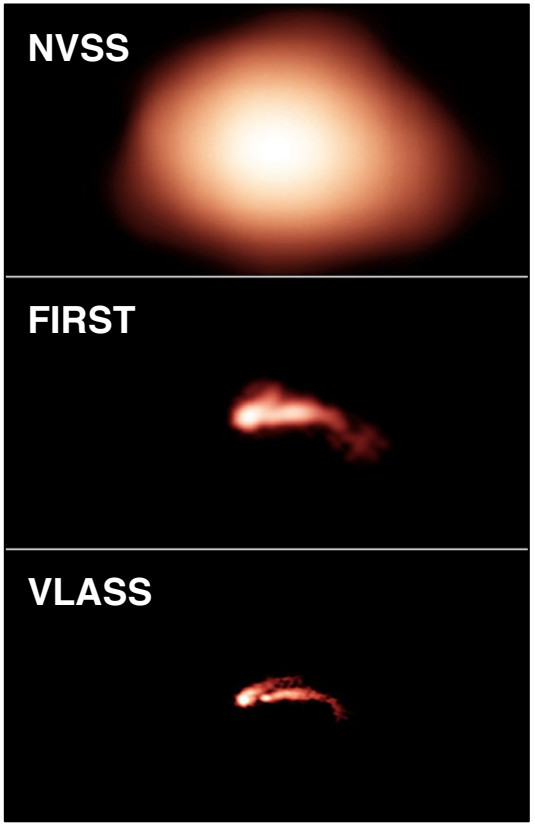
VLA SKY SURVEY

› **Advanced continuum**
  - unbiased view of AGN and star-forming galaxies
  - cross-wavelength matching: optical spectroscopy and morphology, IR photometry, X-ray luminosities
  - radio spectral indices and spectral shapes
  - identification of clustered detected components into single physically associated radio sources

› **Transients**
  - ~5000 transients on ms to year time-scales
  - quality assurance to avoid false positives
  - rapid & robust transient identification
  - transient marshal & automated alerts
  - real-time processing of fast-sampled data

› **Polarimetry**
  - magnetic properties of galaxies as function of *z*
  - Faraday rotation measures (RM)
  - decomposition using RM synthesis
  - cubes of Faraday depth across extended sources



Bill Saxton, NRAO/AUI/NSF

CIRADA and SKA

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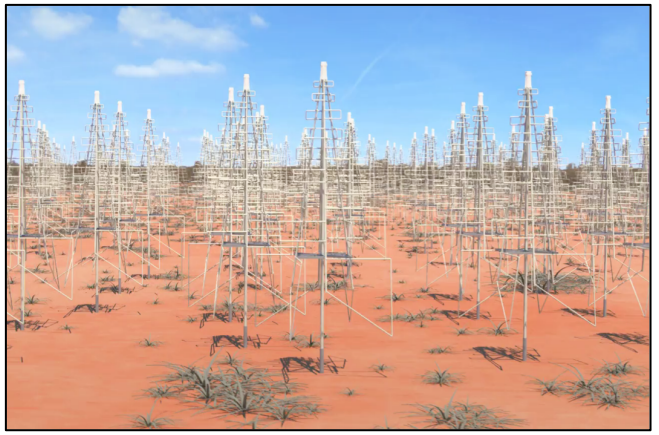
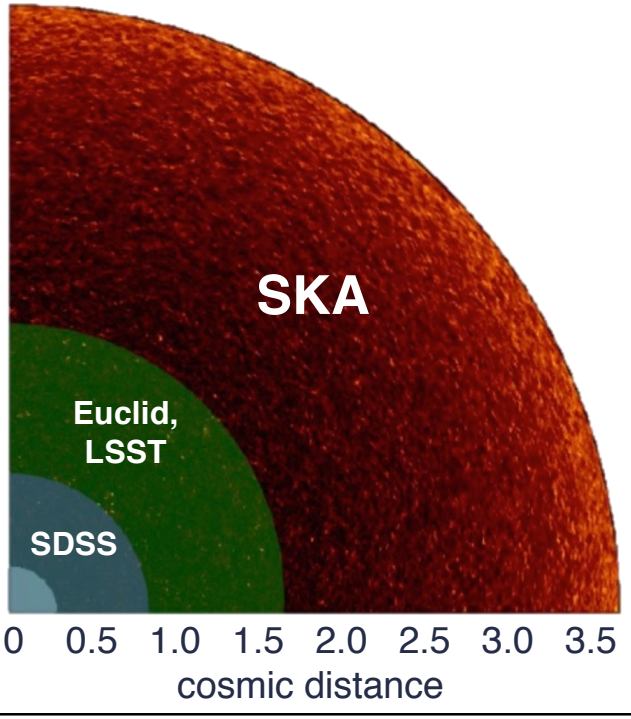
- SKA is a current top priority in Canadian Long Range Plan (2010) & Midterm Review (2015)
- Major NRC leadership in SKA design, while Canadian universities focused on SKA science
- ***Canadian participation in SKA will require a Canadian SKA Regional Centre (SRC)***
- CIRADA
  - path to university engagement in SKA design
  - pilot program for a Canadian SRC
  - establishes SRC capabilities & specifications
  - creates links with other SRC programs
- Discussion needed:
  - costing and time scale for a Canadian SRC
  - role of Compute Canada and CADC
  - funding sources: CFI? Provinces? Other?



SKA Organisation



Alonso (2015)

Summary

CIRADA
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- CIRADA is a major new software infrastructure program for Canadian radio astronomy
- Creates data products needed for ten major science programs using VLASS, CHIME and ASKAP
- All software and data sets will be made publicly available
- Defines path toward a Canadian Square Kilometre Array Regional Centre
- Will be forming CIRADA Users Committee to seek advice on data products and use cases


Andre Recnik


Hayley Bignall

J. M. Flagg / Library of Congress