



NORTH-WEST UNIVERSITY  
YUNIBESITI YA BOKONE-BOPHIRIMA  
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# North-West University Potchefstroom Research Group Overview and Future Plans

*Markus Böttcher*

*SARChI Chair of Astrophysics  
and Space Physics*

# The Center for Space Research (CSR)

Represents all of Physics at NWU

## Main research themes:

Astrophysics

Space Physics

- 14 Faculty / Senior Researchers, incl. 2 new/future Faculty:  
F. Spanier (Würzburg); T. Medupe (Mafikeng)
- 6 Postdocs (Ю. Суц [Yu. Sushch] to arrive in March)
- 16 Ph.D. students
- 12 M.Sc. Students
- 2 Undergraduate (Honors) Students involved in research

Most students and postdocs funded

through NWU + NRF



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# Astronomy/Astrophysics Research

(SARChI Chair M. Böttcher)

## Theory / Numerical Simulations / Modeling

- AGN (M. Böttcher, F. Spanier, Ю. Суц)
- GRBs (M. Böttcher, F. Spanier, Ю. Суц)
- Pulsars (C. Venter)
- PWNe (C. Venter, H. Moraal, S. Ferreira)
- SNRs (S. Ferreira, Ю. Суц)
- Globular Clusters (C. Venter)
- X-ray/ $\gamma$ -ray binaries, microquasars (M. Böttcher, Ю. Суц)
- Diffuse Galactic (J. van der Walt, S. Casanova)
- Masers / High-Mass Star Formation (J. van der Walt)
- Stellar Atmospheres (T. Medupe)
- Galaxy Evolution (I. Loubser)
- MHD (S. Ferreira, Ю. Суц)
- MC radiation and particle acceleration (M. Böttcher)
- PIC (M. Böttcher)

→ Focus on High-Energy Astrophysics

# Astronomy/Astrophysics Research

(SARChI Chair M. Böttcher)

## Observation

- Gamma-Ray: H.E.S.S., Fermi (F. Spanier, C. Venter, P. Krüger, Ю. Суц, J. van der Walt)
- Optical/NIR: SALT, SAAO, CTIO (I. Loubser, J. van der Walt, T. Medupe, M. Böttcher)
- Radio (J. van der Walt)
- Multi-wavelength campaigns (M. Böttcher, I. Loubser, F. Spanier, Ю. Суц)

## Experiment

- Low-Noise Amplifiers / Applied Physics  
(B. Visser, P. Krüger)

# Space Physics Research

(M. Potgieter)

## Theory / Numerical Simulations

- Heliospheric Physics (A. Burger, M. Potgieter, H. Moraal, H. Krüger, S. Ferreira, RdT. Strauss)
- Cosmic Ray Transport --- Solar System to Galactic CR transport (M. Potgieter, A. Burger, H. Moraal, F. Spanier, S. Ferreira, RdT. Strauss, S. Casanova)
- Diffuse Emission from Cosmic-Ray Interactions (M. Potgieter, S. Casanova, J. van der Walt)

## Experiment

- Neutron Monitor Development / Antarctic Research (H. Moraal, B. Visser, G. Benade, H. Krüger)

→ Focus on Cosmic-Ray Physics

# Overarching Research Theme

- Production/acceleration of high-energy particles (CRs) in Pulsars/PWNe, SNR, AGN, GRBs, Galactic binary systems...
- Radiation signatures (spectra, polarization, time variability) of high-energy particles at the source
- Transport of CRs through interstellar and interplanetary space
- Radiation signatures of CR interactions within the Galaxy
- Direct Measurements of CRs (neutrons) on Earth
  
- Build a consistent modeling chain: MHD (large-scale structures) → PIC (microscopic self-generation of fields and particle acceleration) → MC (particle acceleration to the highest energies) → radiation



# Plans

- Strengthen involvement in H.E.S.S. – build close collaboration with other SA H.E.S.S. institutions (Wits and UFS) and others that indicate interest and expertise in high-energy astrophysics
- Strengthen link between astrophysics and space physics efforts, focusing on cosmic-ray physics
- Involvement in CTA: Proposal to NWU (and NRF) to contribute to Italian-led mini-array project; NWU-led CTA site proposal for sites in Namibia
- Strengthen collaborations with multiwavelength partners (HartRAO, SALT, Fermi, Chandra, XMM-Newton, ...) for large-scale, international multiwavelength campaigns

# Astronomy in the North

- Strong concentration of expertise in high-energy astrophysics (NWU, Wits, UFS, UJ) and space physics / plasma physics (NWU), that does not exist in the south. Focus on ties to H.E.S.S. and involvement in CTA.
- HartRAO and connection to radio astronomy (MeerKAT, SKA) is crucial for multiwavelength aspects
- Suggestion: Theme for NASSP North: High-Energy Astrophysics + Plasma Physics, complementary to optical-astronomy focus of NASSP South

