Ulrich Schwarz – a Synthesis Giant

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Outline

- Bern
- Leiden
- Groningen and Dwingeloo
- Sydney and Parkes
- Groningen and Westerbork
- Work with Students
- High-Velocity Clouds
- Arts
- Synthesis

Origin: Bern

Born at Villigen, AG (Switzerland), 11 Oct 1932

Study: Physics and Astronomy, Bern; M.Sc. 1957

Visit Leiden 1957-1958

Work at Physics Institute, Bern, with Geiss and Oeschger

History of Cosmic Radiation;

Isotopic Changes in Meteorites and on Earth

Ph.D. Feb 1962; “Entwurf eines Photometers”

Leiden 1957-1958

Radio Astronomy: Receiver development, with Charles Seeger

Some observing at Dwingeloo

Musical evenings at assistants' home: Kwee Kiem King

Leiden 1957-1958

Radio Astronomy: Receiver construction, with Charles Seeger

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Visitors include Betty van Woerden

Betty visits Switzerland several times,

learns to ski

Ulrich and Betty marry 9 Dec 1961

Groningen 1962-1968

Visits Kapteyn Institute in 1960 and 1961

Appointed staff member 1962, replacing HvW 1962-1964

Research with Dwingeloo 25-meter telescope:

- properties of interstellar hydrogen clouds (with HvW)
- survey at intermediate galactic latitudes (with HvW and Takakubo)
- component analysis of hydrogen 21-cm profiles

  (Kaper et al. 1966; Schwarz 1968)
- survey of hydrogen at high galactic latitudes

  (with Muller, Raimond and Tolbert)
- hydrogen recombination lines (H166α) in Hii regions

  (with De Boer, Hin and HvW)

Westerbork synthesis telescope under construction!

Sydney 1968-1970

On staff of Division of Radiophysics, CSIRO, at Epping

Research on pulsars and southern radio sources,

with Dave Morris, Douglas Cole and others

Parkes Survey of 21-cm Absorption in Discrete-Source Spectra

Parkes hydrogen-line interferometer: 64-meter and 18-meter dishes

Radhakrishnan, Brooks, Goss, Murray and Schwarz (1972, ApJS 24, 1)

Ulrich became an expert in radio interferometry,

and its use for aperture synthesis with

Westerbork Synthesis Radio Telescope

Groningen 1970-1996: Westerbork Studies

Small-scale structure of interstellar clouds (with Wesselius, Kalberla, Goss)

1978-1993; later (1995-1997) also with VLA

Recombination lines from compact Hii-regions

(with Jacqueline van Gorkom, Goss, Shaver, Harten, 1980)

Magnetic fields through Zeeman splitting of 21-cm absorption

(with Bregman, Goss Heiles, Troland, 1983-1986)

Supernova remnants (SNR): relations with pulsars (with Weiler and Goss, 1974)

SNR distances and structure (with Goss, Wesselius and Arnal, 1973-1980)

Groningen/Westerbork 1970-1996 (2)

Galactic Centre (GC) source Sgr A

- Westerbork-Owens Valley (WORST) map:

  Ekers, Goss, Schwarz, Downes, Rogstad (1975, A&A 43, 159)

- 21-cm absorption in the Galactic Centre:

  Schwarz, Shaver, Ekers 1977; Schwarz, Ekers, Goss 1982

- H110α recombination line: Bregman & Schwarz 1982

Detailed structure of Sgr A (with the VLA):

Ekers, van Gorkom, Schwarz, Goss (1983)

Goss, Schwarz, van Gorkom, Ekers (1985)

Recombination-line obs.; distribution and motions of ionized gas in GC:

Van Gorkom, Schwarz, Bregman (1985)

Schwarz, Bregman, van Gorkom (1989)

Groningen/Westerbork 1970-1996 (3)

Studies of External Galaxies

Neutral hydrogen distribution in S0 galaxies

(disk galaxies without spiral structure)

with HvW, van Driel, Gallagher, Knapp, 1983-1988

The peculiar galaxy NGC 3718 and its companion NGC 3729

Schwarz (1985, A&A 142, 273)

The warped and twisted gas disk in NGC 3718 (VLA observations)

Sparke, van Moorsel, Schwarz, Vogelaar (2009, AJ 137)

Groningen/Westerbork 1970-1996 (4)
Software

CLEAN: correction for effects of incomplete coverage of aperture plane.

Invented by Jan Högbom (1974).

Vital for quality and sensitivity of Westerbork maps.

Schwarz (1978, A&A 65, 345): “Mathematical-statistical description of the iterative beam-removing technique (Method CLEAN)”.

Multi-Resolution CLEAN: Wakker&Schwarz (1988, A&A 200, 312)

“The Multi-Resolution CLEAN and its application to the short-spacing problem in interferometry” (Combination of long- and short-spacing observations)

Ulrich’s software is “clever” (Jacqueline van Gorkom) and
“mathematically precise and reliable” (Martin Vogelaar)

Groningen: Work with students

- Courses in radio astronomy

  Practical work: 2-element radio interferometer (PQRS)

- PhD thesis projects

  Marco de Vos (1992): Optical Interferometry with SCASIS

  SCASIS = Seeing-Corrected Imaging Spectrometry

  with Jaap Bregman (NFRA, Dwingeloo)

  Bart Wakker (1990): Interstellar Neutral Hydrogen at High Velocities

  with Hugo van Woerden and Joel Bregman (NRAO, Charlottesville)

High-Velocity Clouds

HVCs: Neutral-hydrogen clouds with abnormal velocities.

Discovered by Muller, Oort and Raimond (1963).

Nature and origin long remained mysterious.

First Westerbork observation: Schwarz, Sullivan, Hulsbosch (1976).

Filamentary structure; density in concentrations.

Detailed study of Cloud AI: Schwarz and Oort (1981).

Bizarre complex structure and motions.

Small-scale structure and motions in many HVCs: Wakker and Schwarz (1991).

Major effort, with Wakker and HvW, 1984-2004.

Many conference contributions.

Book: "High-Velocity Clouds", Kluwer 2004;

editors: HvW, Wakker, Schwarz, K.S. de Boer; 17 chapters, 400 pages

UJS chapters: - The large- and small-scale structure of HVCs (with Wakker);

- Kinematics of high-velocity and intermediate-velocity gas (with De Boer).

Key to Origin: Distance and Composition ("metallicity").

HVCs: Distance and Metallicity; Origin

Method: Spectra of stars in halo (different distances) and of quasars.

Absorption lines of CaII or other ions at HVC's velocity?

In star spectra => upper or lower limits to HVC distance;

in quasar (or other EG) spectra => metallicity information.

Full analysis of method: Schwarz, Wakker, HvW (1995), A&A 302, 364.

CaII absorption in Pks 0837-120: Robertson, Schwarz, HvW ++ 1991, MN 248.

Distance of Chain A: HvW, Schwarz, Wakker, Peletier, Kalberla (1999, Nature 400, 138).

Metallicity of Complex C: Wakker, HvW, Schwarz et al. (1999, Nature 402, 388).

Several more results since then. Tentative conclusions:

- Intermediate-velocity clouds ($|V| < 100$ km/s) have ~ solar metallicity,

part of "Galactic Fountain" (Bregman 1980): SN-driven circulation in Galactic Halo;

- Higher-velocity clouds have low metallicity (~ 0.1 x solar); origins:

Infall of tidal debris of Magellanic Clouds or dwarf galaxies; intergalactic clouds?

cf. original hypothesis by Oort (1966).

Arts

Ulrich plays the flute in family concerts
and has played in Kapteyn Orchestra.

Ulrich is an accomplished painter
water colours and woodcuts
many Observatory paintings.

SYNTHESIS

Ulrich has synthesized:

- Physics, mathematics and astronomy
- Optical and radio astronomy
- Single-dish astronomy and interferometry
- Interstellar, Galactic and extragalactic astronomy
- Dozens of collaborators from all over the world
- Research and teaching (incl. Mathematics for Kids)
- Science and Arts
- Work and Fun
- Friendship with many

A SYNTHESIS GIANT

THANK YOU, ULRICH!!