

# Apertif Imaging Surveys Science

Betsey Adams Head of Apertif Science Operations 6th LOFAR data school 25 March 2021





## WSRT: An east-west array









#### Westerbork Kamp









# Imaging surveys science

- Continuum
- Neutral Hydrogen
  - Dwarf galaxies
  - Accretion/removal of gas
  - Environmental processing
  - Resolved kinematics • Polarization
    - magnetic fields



- Star formation (faint radio population)
- HI absorption
- Synergy with LOFAR





# The radio view of galaxies

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#### MPIfR, M. Krause & CFHT/ Coelum AST(RON

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# The radio view of galaxies

- Neutral Hydrogen
  - Dwarf galaxies
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2007: Oosterloo, Fraternali & Sancisi

• Continuum

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### Continuum: Apertif and NVSS







A. Kutkin



## Discovery of intra-hour variables



**APERture Tile In Focus** 

Left: **Discovery** image of the first IHV discovered in Apertif wide data

*Right:* in the same Apertif field

T. Oosterloo + H. Vedantham + A. Kutkin + Builders (2020 A&A)

- Three candidate IHVs within one degree, contained



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# Continuum synergy with LOFAR

Resolved spectral indices of extended sources in the Lockman Hole to identify sources with steep spectral indices to constrain the timescale of the radio galaxy life cycle







R. Morganti et al. (including Apertif imaging team), 2021





Right Ascension (J2000)

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# Continuum synergy with LOFAR



**APERture Tile In Focus** 

Faint, diffuse radio source J1450+5716 identified in Apertif and LOFAR maps at 1400 and 144 MHz.

Likely origin is a remnant of AGN activity



Orru+ in prep



# Continuum synergy with LOFAR



**APERture Tile In Focus** 

Discovery of a giant radio tail in Mrk273

*Left:* Full field of view Apertif mosaicked continuum image

Upper right: Apertif image/contours of Mrk273 with regions annotated

*Lower right:* LOFAR-Apertif spectral index map

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#### Aperpol: Apertif polarization analysis pipeline APSVC 340.415+33.823

*Left 3x3:* Example inspection plots from Aperpol

Right panels: Comparison of polarized source properties to **NVSS** 



Fractional Polarisation + PI-contours  $FP = 2.53 \pm 0.0\%$  $P(NVSS) = 2.42 \pm 0.12 \%$ 51 5000.0) وC. (2000.0) کام. مور، (2000.0) Fractional Pelarisation 0 0.02 0.04 0.06 0.08 0.1

SDSS G + TP-contours  $SDSS(G) = 23.97 \pm 0.4 \text{ m}$  $SS(R) = 22.08 \pm 0.13 m$  $SS(1) = 20.94 \pm 0.08$ 51′  $(Z) = 20.31 \pm 0.19$ 50 33°49′00″ 45<sup>s</sup> 22<sup>h</sup>41<sup>m</sup>40<sup>s</sup> 35<sup>s</sup> 30<sup>s</sup> 50<sup>s</sup>

Total power + PI-contours



WISE 3.4  $\mu$ m + TP-contours



WISE 12  $\mu$ m + TP-contours



22<sup>h</sup>41<sup>m</sup>40<sup>s</sup> 35<sup>s</sup> 45<sup>s</sup> R.A. (2000.0)







Rotation Measure + PI-contours RM = 57.5±1.7 rad/m (NVSS) = -152.7±9.9 rad/m Rotation Measure [rad/m<sup>2</sup>] -100 -50 0 50 100

WISE 4.6  $\mu$ m + TP-contours



WISE 22  $\mu$ m + TP-contours



45<sup>s</sup> 22<sup>h</sup>41<sup>m</sup>40<sup>s</sup> 35<sup>s</sup> 50<sup>s</sup>







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#### B. Adebahr

30<sup>s</sup>

### Polarization source counts

*Left:* Polarized intensity image of a GOODS-North field

*Right:* Polarized source counts for the two observed GOODS-North fields plus five fields from the Science Verification Campaign





A. Berger (part of PhD thesis)

<sup>m</sup>00<sup>s</sup> R.A. (2000.0)



#### Apercal: Automated processing of imaging data

- Fully-automated processing for survey
- Direction-independent calibration
- Produces (non-primary beam corrected !):
  - Continuum mfs images
  - Stokes V mfs image
  - Stokes Q & U cubes
  - Four (dirty!) spectral line cubes plus dirty beam cubes





Adebahr+, in prep.

Netherlands Institute for Radio Astronomy



### Apertif data and you

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https://vo.astron.nl

Getting Started

#### The VO @ ASTRON AST(RON

Welcome to the ASTRON VO data center.

In addition to the services listed below, on this site you probably can access numerous tables using TAP or form-based ADQL.

Please check out our site help.

Services available here

Services marked by [P] require authorisation to access the data.

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