Determination of radio spectra from catalogues and identification of Gigahertz peaked sources (GPS) from the Virtual Observatory

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The project

- Aim: extract radio cross-ids / spectra from a homogeneous set of catalogues
- Scientific goal: datamining to search for peculiar sources (e.g. GPS sources = young radio loud AGNs not well understood) + the role of variability in a multi-epoch database
- Results: (i) catalogue of radio spectra (VizieR) =

  added value data for the VO

  (ii) follow-up simultaneous observations at 3 frequencies: assess source variability; search for new GPS sources

  (ii) prototype of a VO tool for intelligent data discovery
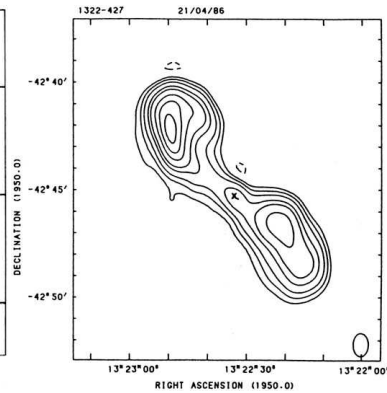
Radio surveys

- Single dish ⟷ Interferometer
- Systematic / pointed (finder) surveys
- Main characteristics:

  - Sky coverage

  - Frequency → *m/cm wavelength range*

  - Angular resolution (beamsize)

  - Sensitivity

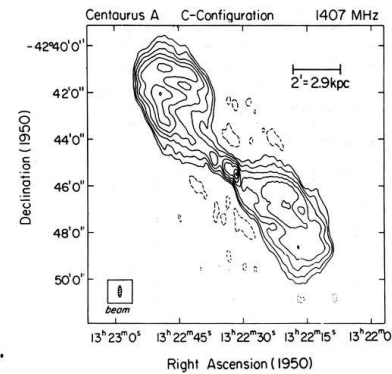# Cross-identification of radio sources – the influence of frequency
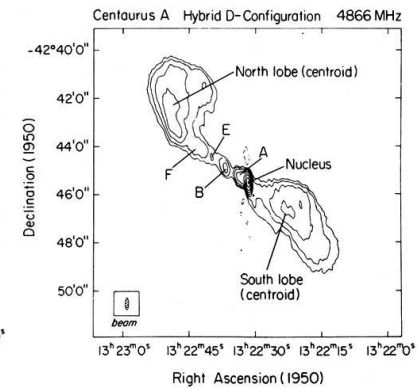
Example: Cen A
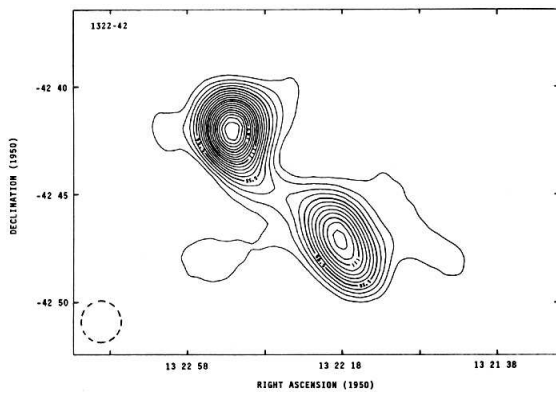
1.9m
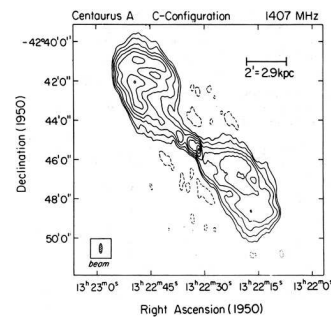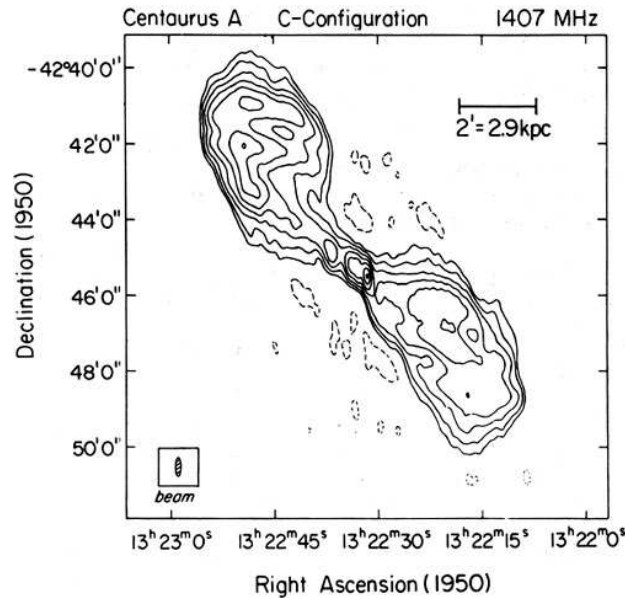(Slee 1977)

35cm
(Paul et al. 1992)

20cm
(Burns et al. 1983)

6cm
(Burns et al. 1983)

Increasing frequency

Cross-identification of radio sources- the influence of resolution
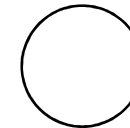
Centaurus A   C-Configuration   1407 MHz

at a larger distance:

VLA, 20cm (Burns et al. 1983)
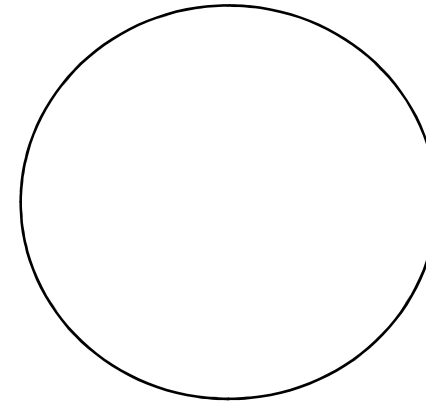
Green Bank
20cm
10'

Green Bank
6cm
3.5'

VLA, NVSS
20cm
45"

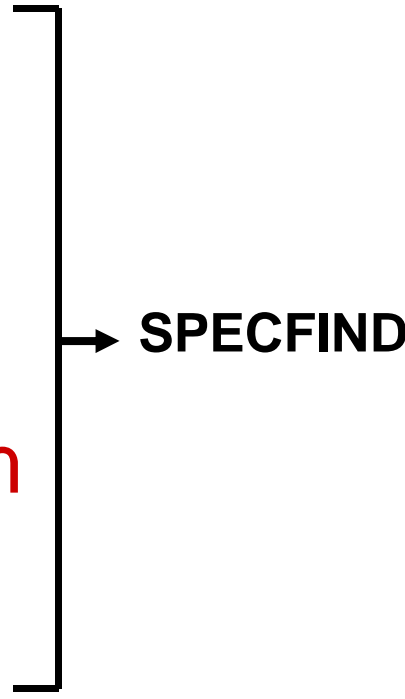VLA, FIRST
20cm
5"

Cross-identification of radio sources

Based on
- on proximity / resolution / source extent
- comparison of fluxes at the same frequency
- radio spectrum (radio SED)
- physical characteristics (e.g. galaxies, SN remnants, AGNs)

Steps for cross-identification

- Search for, preparation of and uniformization of radio catalogues → **VO tool**

- Definition of code standards
- Proximity search
- Selection based on fluxes at the same frequency → **SPECFIND**
- Selection based on radio spectrum
- Self-consistency of the final catalogue

SPECFIND: some example spectra
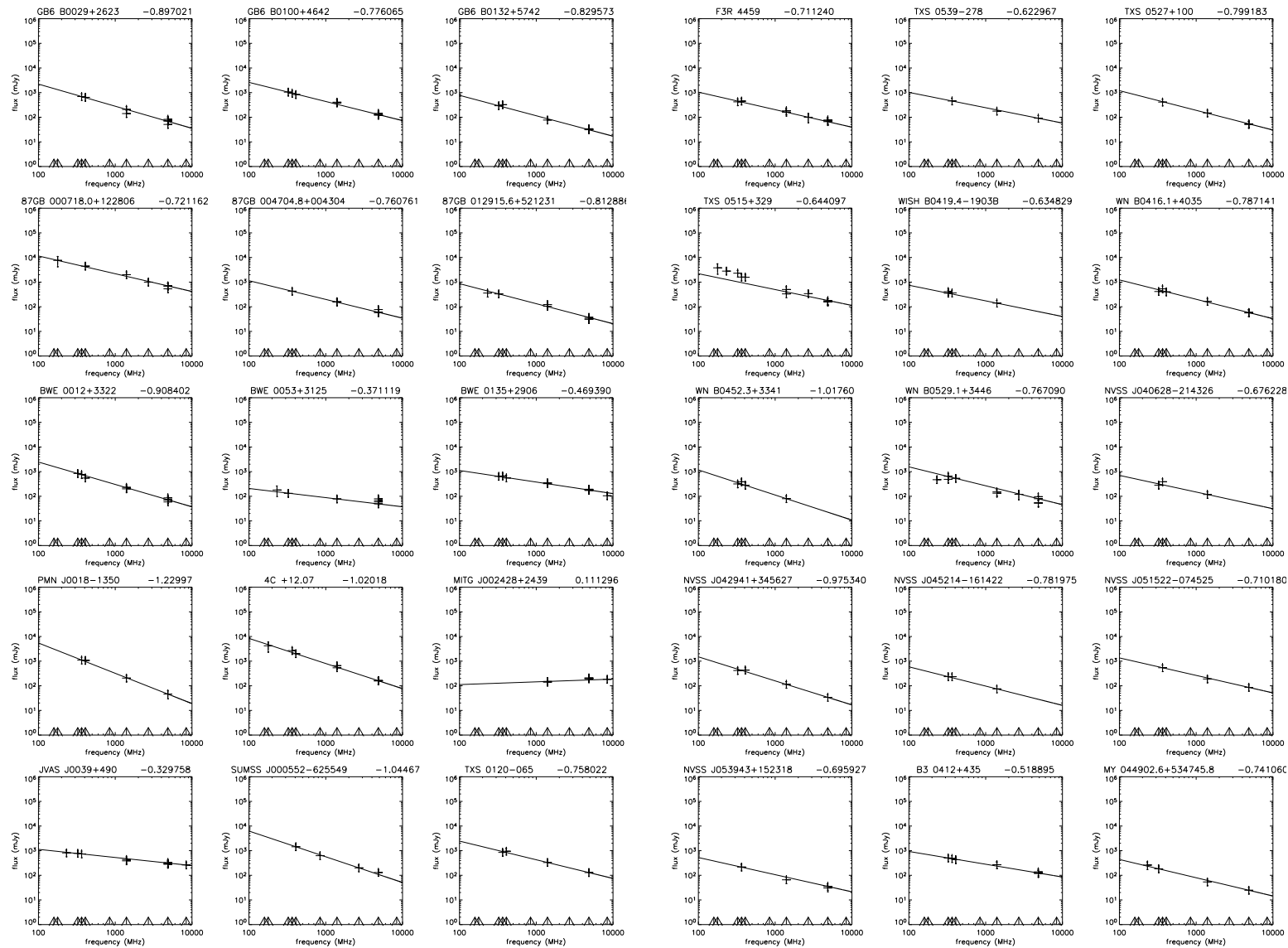
SPECFIND

(Vollmer et al., 2005a, 2005b)

- 22 radio catalogues included
- 11 different frequencies
- 3.5 million sources (half of them are from the NVSS)
- Results: ~760,000 independent associations
  ~67,000 independent radio spectra with more than 2 independent points

    -> more than an order of magnitude more than previous works
    (e.g. Vigotti et al. 1989, Kulkarni et al. 1990)

- Cross-ids and spectra available in VizieR at CDS

Scientific follow-up project

- Datamining of the SPECFIND database
- Search for sources with *inverted radio spectrum* => variability; possible *Gigahertz peaked sources* (GPS: young radio loud AGN's not well understood) or futur mm-VLBI targets
- Quasi-simultaneous observations of these sources at three frequencies (4.8 GHz, 10.4 GHz, 32 GHz) with the Effelsberg 100m telescope
- Comparison of spectra from data at different epochs with data at the same epoch =>

  source variability => potential candidates for intraday variable (IDV) sources

GPS source observations: results
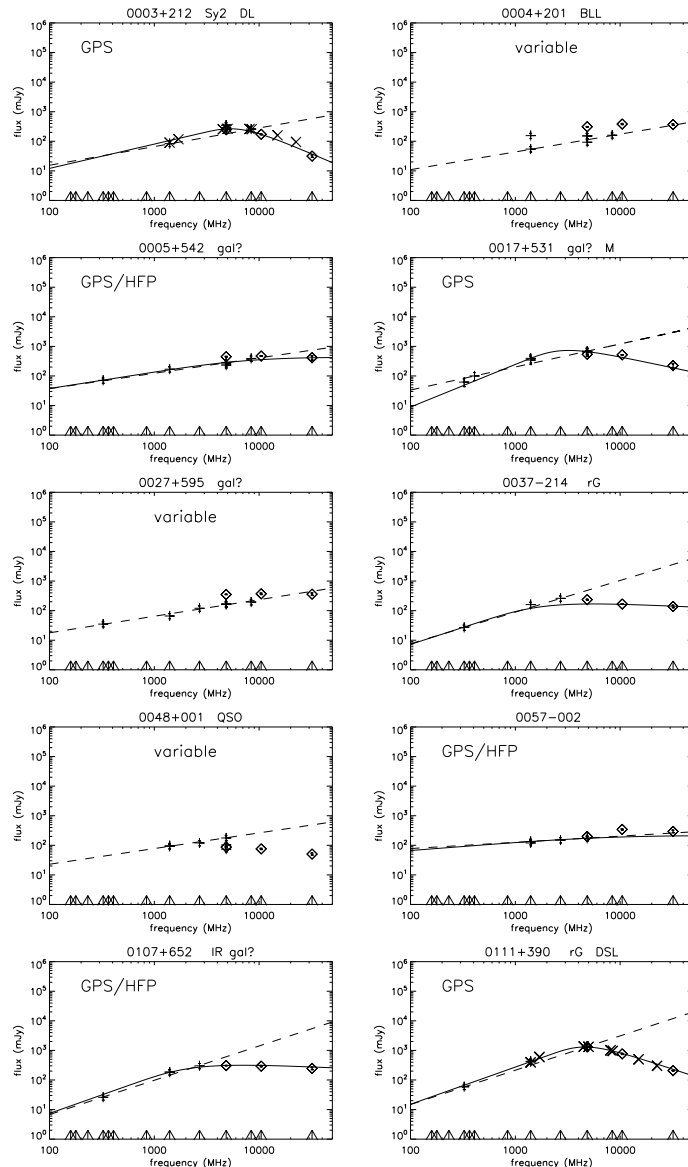
- more than 50% of the sources show a peak at ν >1GHz

- ~50% of the sources are variable

- ~20% of the sources have flat spectra up to 9 mm

- <10% uncertain classification

Going further with VO capabilities

Towards a new VO tool

- Preparation and uniformization of radio catalogues very time consuming
- Aim: include a maximum of available radio catalogues (>100)
- Within the framework of VOTECH at CDS:

    development of

    (i) a tool to search for useful catalogues in the Virtual Observatory

    (ii) a tool to extract relevant information and to uniformise the catalogue information
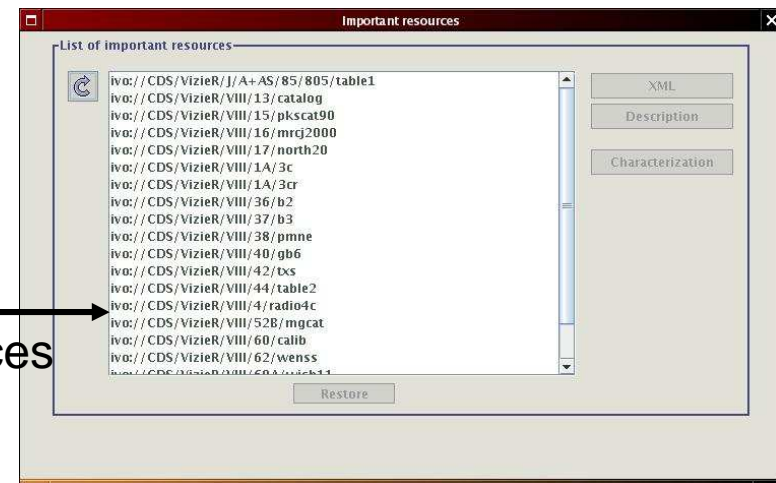
    (iii) a tool to characterise the data

I. Registry query tool

- Finding VO resources based on Unified Content Descriptors (UCDs) matching a query (written in Java; uses XMLDV API to get data from an XML registry)
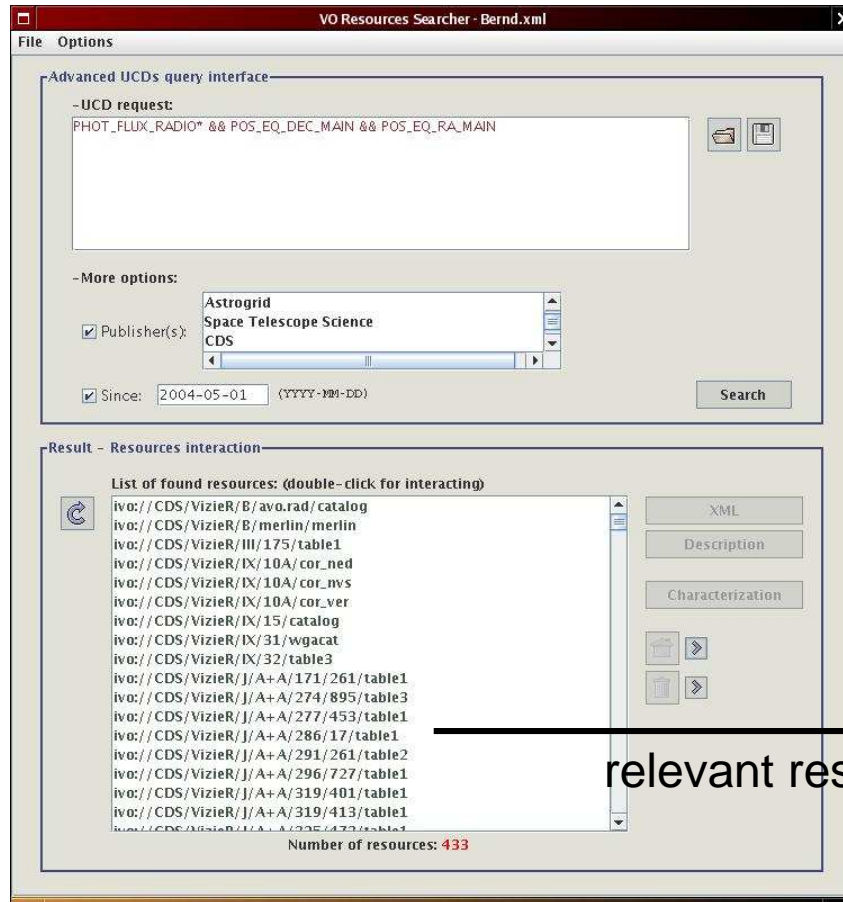
UCD examples:
Radio flux: PHOT_FLUX_RADIO*
Right ascension: POS_EQ_RA
Declination: POS_EQ_DEC

II. Data homogenisation tool

- Aim: extraction of homogenized data from a heterogeneous set of catalogues (Java; works on XML tables)
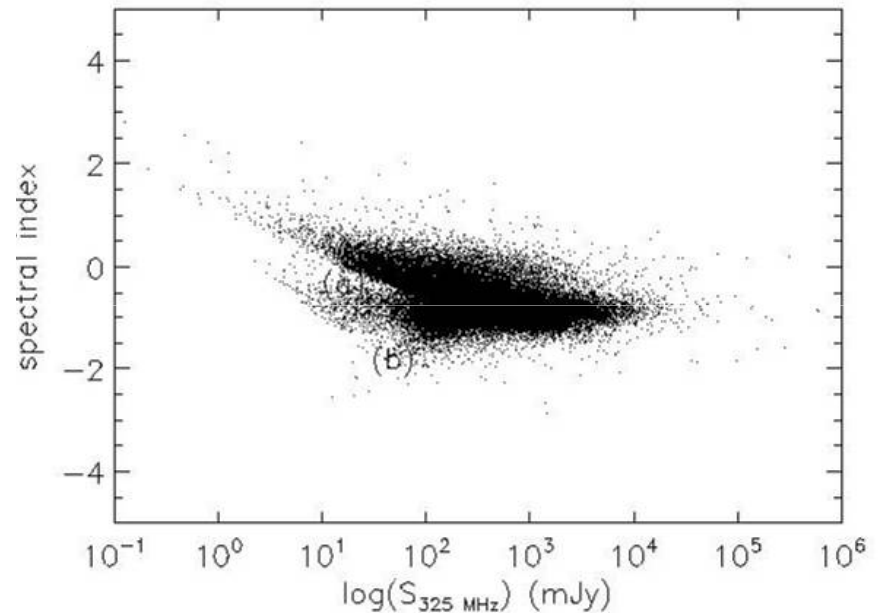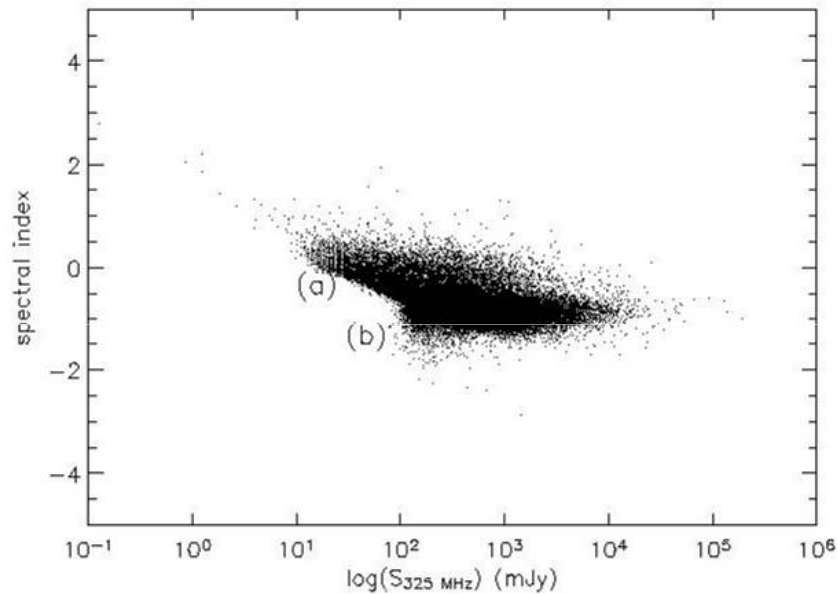- Output: VOTable or ASCII

homogenization interface

III. Characterisation tool

- Implementation of the VO « characterization » data model
- Serves as input for the homogenisation tool

SPECFIND: next release

VizieR catalogue VIII/74A
22 radio catalogues
3.49 million sources
67000 objects

→

new release
105 radio catalogues
3.76 million sources
84000 objects

Summary

- A tool to extract radio spectra from a large set of radio catalogues is available (SPECFIND)
- Results for 22 radio catalogues are published and available in VizieR at CDS (Vollmer et al. 2005a,b)
- Scientific follow-up projet based on the datamining of the SPECFIND spectra is in progress (submitted to A&A)
- Within the framework of VOTECH at CDS:

  development of

  (i) a tool to search for useful radio catalogues in the Virtual Observatory

  (ii) a tool to extract relevant information from these catalogues and to uniformise the catalogue information

  (iii) a tool to characterise the data

- Prototypes available at
  http://eurovotech.org/twiki/bin/view/VOTech/SedConstruction2