Data Processing and Radioastronomy

Participants

- Chiara FERRARI (responsible of the A.N.R. project OPALES - "Non-thermal processes in galaxy clusters")
- Claude AIME
- Albert BIJAOUI
- Sebastien BOURGUIGNON
- Mégane DIET
- Luigina FERETTI (connected via teleconference)
- David MARY
- Eric SLEZAK

Main aims

The radio sky has been surveyed in the last years at different frequencies (1.4 and 4.8 GHz; 74, 326 and 843 MHz; ...) with typical resolutions of several tens of arc-seconds. Radio surveys characterized by higher sensitivity and better angular resolution will be available in the next decades from low (10 MHz) to high (15 GHz) radio frequencies thanks to incoming and future radio facilities, such as the the Expanded Very Large Array (EVLA), the Low Frequency Array (LOFAR), the Long Wavelength Array (LWA), the Australian Square Kilometre Array Pathfinder (ASKAP), the Karoo Array Telescope (MeerKAT), and, last but not least, the Square Kilometre Array (SKA).

Tera-bytes of (3D) radio maps will be produced, for which automatic tools for the detection and physical characterization of radio sources are deeply needed. In this framework, the responsible of the project OPALES has organized a meeting between researchers expert in image processing and in radio data analysis. The main aim of the meeting is to discuss about the existing tools for radio source finding and measurement and the possibility to implement new algorithms adapted to the particular needs of radio data. This includes the capability to take into account variate and more or less complex morphologies of galactic and extra-galactic radio sources, as well as complex patterns related to deconvolution problems in aperture synthesis maps.

Introductory talk

C. Ferrari gives an introductory talk with a short overview of the main needs for automatic radio source finding and measurement.

Discussion

The discussion has been focused on the radio images of galaxy clusters shown during the talk and obtained by applying classical deconvolution methods (e.g. "classical" CLEAN). In the case of complex fields, characterized by the presence of bright point sources, complex morphology radio galaxies and diffuse, extended radio sources, the need of more performant imaging techniques emerges as the main requirement before any possible source extraction tool can be conceived.

Major advances in imaging techniques for radio interferometric data have been made in the last years, such as the Multi-Scale CLEAN Deconvolution and Multi-Frequency Synthesis Imaging (see Sect. V of Rau et al. 2009, IEEEP, 97, 1427 for a review).

All the participants to this meeting working on signal processing agree on the deep interest in applying compressed sensing imaging techniques to radio interferometric data (e.g. Wiaux et al., 2009, MNRAS, 395, 1733; Wiaux et al., 2009, MNRAS, 400, 1029). By imposing the sparsity or compressibility prior on the reconstruction, these techniques offers a very powerful and adapted imaging technique for array synthesis data. Source extraction algorithms would then directly follow from this imaging approach.

This kind of approach have already started to be investigated within the working groups of the different new generation radio telescopes [see for instance the meeting organized next August in Leiden: CALIM 2010: The 5th SKA Workshop on Calibration and Imaging; chair of the SOC: Tim Cornwell (ATNF)]. The group of researchers in Nice expert in image processing (and in particular the participants to this informal meeting in Nice) have expressed their interest in participating and bringing their competence to the research field of compressed sensing imaging techniques for radio interferometric data. C. Ferrari, involved in LOFAR, ASKAP and MeerKAT survey projects, is extremely interested in working on a joint effort between people in Nice and in the different working groups. Other radio astronomers that collaborate with C. Ferrari have also expressed their potential interest in participating to this work.

Questions and needs

The essential point is now to know if joint efforts for the optimization of the imaging and subsequent source extraction phases can be planned between the LOFAR / ASKAP/ MeerKAT groups and people in Nice. In such a case, on short terms, we would need:

- Documentation about the existing (or under development) tools for the imaging and source extraction phases and, of course, the persons to contact to develop this joint research work.
- (Simulated) visibilities of LOFAR / ASKAP / MeerKAT observations of point-like radio sources, tailed or complex morphology radio-galaxies, diffuse radio sources (e.g. radio halos/ relics in clusters) to start making tests.