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A novel radio imaging method for physical spectral index modeling

*Emilio Ceccotti(1), André Offringa(2), Léon Koopmans(1)

(1) Kapteyn Astronomica Institute, University of Groningen, PO Box 800, 9700 AV Groningen, The Netherlands, ceccotti@astro.rug.nl, koopmans@astro.rug.nl
(2) Netherlands Institute for Radio Astronomy (ASTRON), PO Box 2, 7990 AA Dwingeloo, The Netherlands, offringa@astron.nl

Accurate modeling of sky sources is of fundamental importance for calibrating radio interferometric data. In this talk, I will present a new method, called "forced-spectrum fitting", to generate models with physical spectral indices. This method uses a pre-existing spectral index map to assign spectral indices to each clean component during a multi-frequency deconvolution. Together with multiscale deconvolution, it allows obtaining very accurate models. I will show results obtained from LOFAR data, in particular from new observations of 3C61.1 and simulations of 3C196. The FR-II galaxy 3C61.1 is of particular interest because it is the brightest and most complex source near the North Celestial Pole, the main field observed by the LOFAR Epoch-of-Reionization Key-Science Program. Accurate spectral modeling is especially important for observations of the 21-cm line emitted by the neutral hydrogen during the Epoch of Reionization. One of the main challenges of 21-cm experiments are the bright astrophysical foregrounds. To mitigate the foreground emission, the sky emission is modeled and then subtracted from data, trying to extract the 21-cm signal from the residuals. A complete model with spectral information is then required to reduce calibration errors and contamination from such subtraction. When comparing forced-spectrum results with those from standard polynomial fitting, it is evident that residuals are more uniform, especially when a ground-truth spectral index map is used, and physical spectral models of sources are produced. This can benefit the calibration of interferometric data and, in particular, 21-cm power spectrum estimates.