SED Modelling with SKAMPI: The Large Magellanic Cloud

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Motivation

Understanding galactic foreground emission is crucial for accurate studies of the cosmic microwave background (CMB). To do so, observations at a wide range of radio frequencies are necessary.
We use S-Band observations from the new SKAMPI telescope, where synchrotron- and free-free emission are prominent.
To test the S-Band survey, conducted with the new SKMAPI telescope (Jünemann et al. in prep.), we look at the Large Magellanic Cloud, which has been extensively targeted by a number of studies ([1]-[4]). In doing so we improve the understanding of the spectral energy distribution (SED) of the LMC.

SKAMPI

The SKAMPI telescope, built by the Max Planck Society as an SKA prototype, is located in the Karoo desert (South Africa). It features a 15 m offset-Gregorian dish with S- and Ku-band receivers (1.75–3.5 GHz and 12–18 GHz). In S-band, the angular resolution ranges from 25 arcmin to 50 arcmin. SKAMPI is capable of full-Stokes observations (I, Q, U, V).

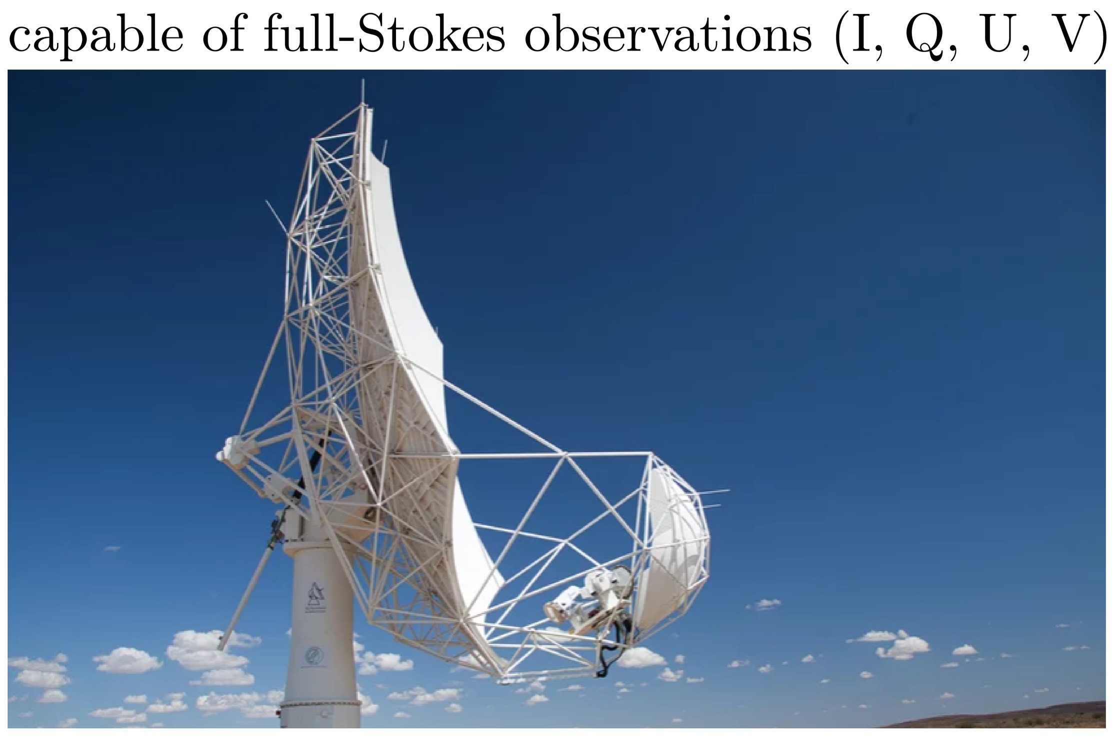
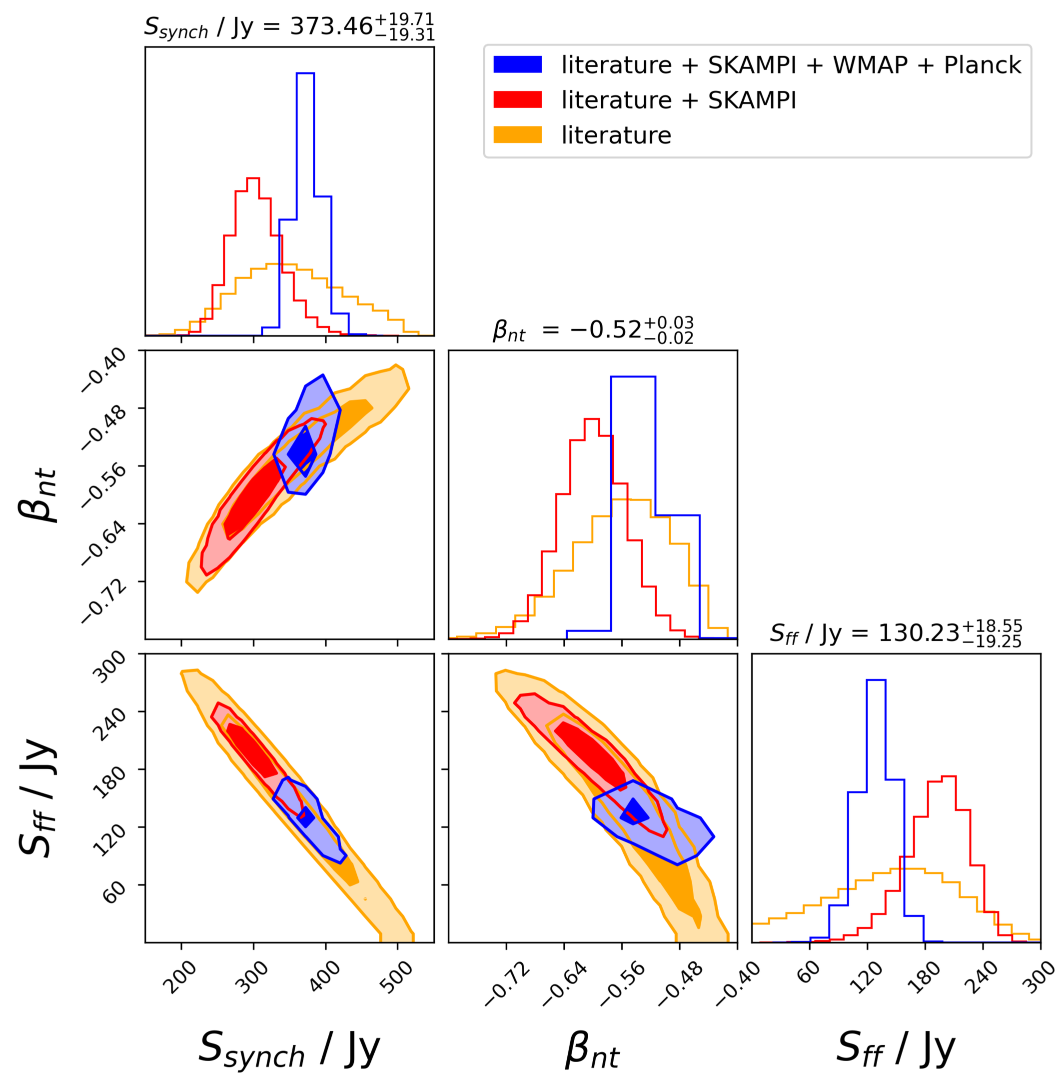


Image: MPIfR / Gundolf Wieching

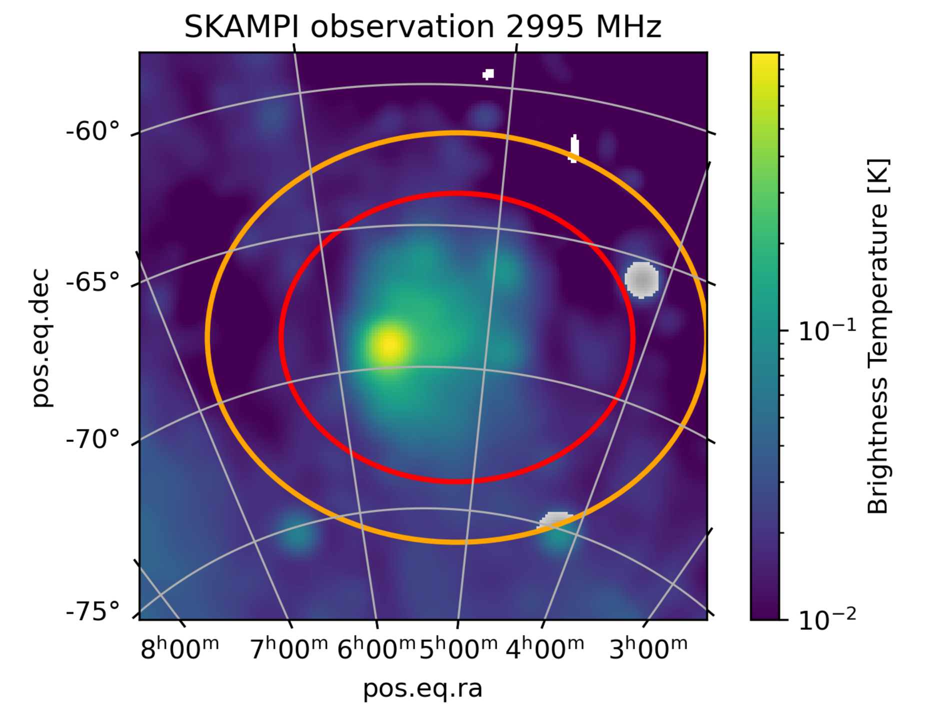
Best-fit results



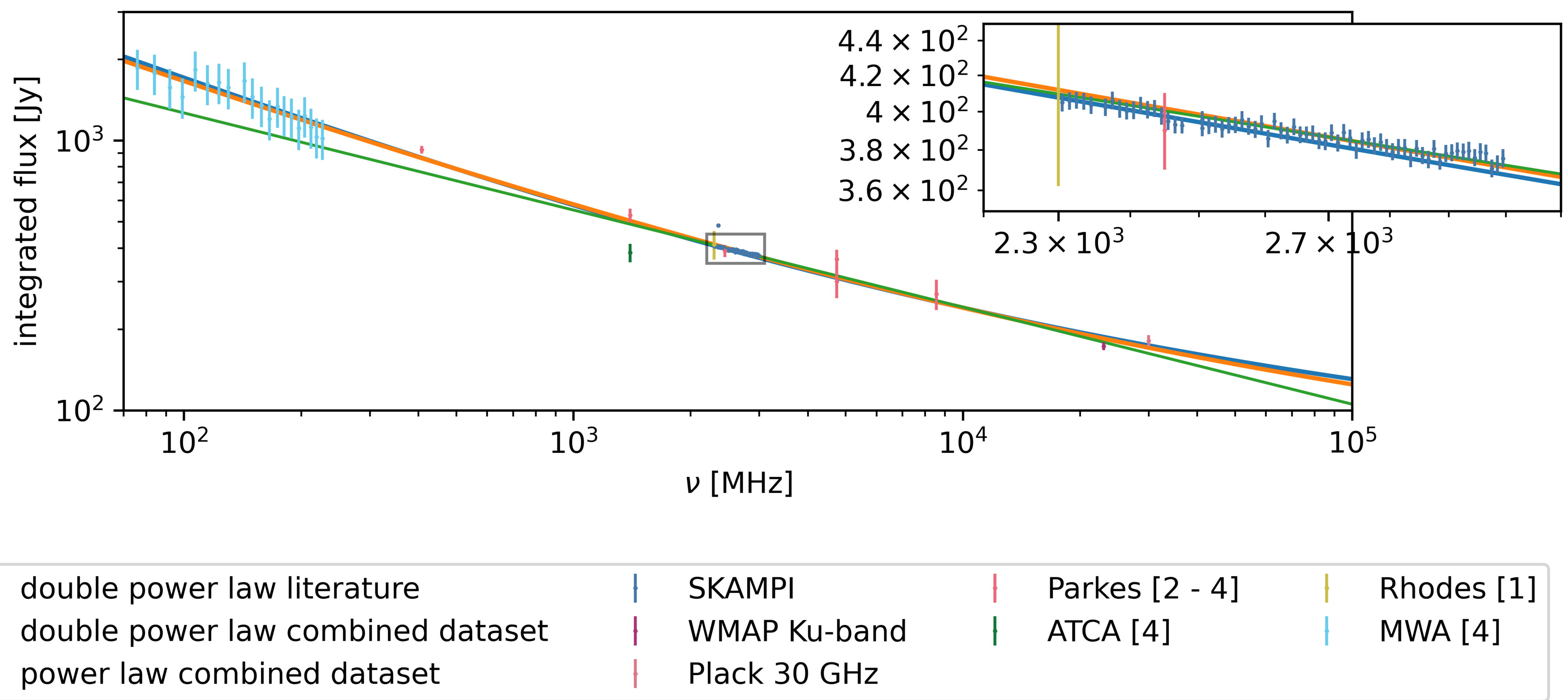
Shown are the best-fit double power law results using the SKAMPI data, with and without the inclusion of the lowest Planck and WMAP channels, as well as as the dataset used in [4].
The reference frequency is $\nu_0 = 1.4\,\mathrm{GHz}$.
The value above the histograms corresponds to the blue contours.

SKAMPI S-Band Southern-sky survey

We use cutouts from the SKAMPI total intensity southern sky survey (Jünemann et al. in prep.). For our analysis we focus on the 2.3–3.0 GHz observations. The survey uses 10 MHz frequency bins. We smoothed all maps to a common resolution of 1 deg.
We calculate the integrated emission within the red ellipse (see image on the right). The zero-level and rms are calculated as the median and standard deviation in the annulus between both ellipsis after masking point sources via sigma clipping (greyed pixel).
To increase the frequency range, we calculate integrated fluxes from the publicly available Planck 30 GHz channel and WMAP K-band maps in the same way as described above.



SED



We combine our calculated flux values with the literature values given in [1] - [4], to achieve a broad frequency coverage. We fit a power law as well as a double power law of the form

$$S(\nu) = S_{ff}\left(\frac{\nu}{\nu_0}\right)^{-0.1} + S_{synch}\left(\frac{\nu}{\nu_0}\right)^{\beta_{nt}}, \quad (1)$$

which describes synchrotron emission with a free spectral index β_{nt} and free-free emission with a fixed spectral index of -0.1.
The values obtained from SKAMPI are consistent with the literature. The spectral index of the SKAMPI data of -0.36 ± 0.04 agrees within 1-sigma with the spectral index achieved by evaluating the double power law given in [4] between 2.3–3.0 GHz.
Combining the datasets gives a good fit for the double power law model. The combination leads to a significant reduction in the uncertainties of the best-fit parameter. This in turn will lead to more accurate estimates of e.g. the star formation rate. Additionally this shows SKAMPIs capability to improve synchrotron and free-free foreground models used in e.g. CMB and HI studies.

Conclusion

We showed the consistency of the new SKAMPI observations with existing data.
Adding it to existing data sets leads to a significant reduction in best-fit parameter uncertainties.

Outlook

In the future we plan to extend the study to other objects as well as diffuse Milky Way emission. The goal is to create a foreground map to be used by e.g. CMB and HI experiments.

References

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