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Title: `Pixel space convolution for cosmic microwave background experiments`

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Referee report

Dear Editor,

this paper presents a new implementation of a real space beam convolver suitable for CMB experiments called PISCO. The authors describe in detail the algorithm a prototype implementation, performing also a validation of the method. They also discuss briefly the performance of the method in some simple cases. Despite such problem has been already discussed in several other papers, and solved by other (in some cases public) codes or libraries, this method has the merit of being the only available implementation (to my knowledge) of a real space convolver able to produce realistic TODs, being Febecop only devoted to maps convolution. For this reason, in my opinion, the paper deserves to be punished on JCAP. However the paper needs both major and minor revisions, which I am listing in the following:

Major revisions:

1. The Performance sub section is rather empty, especially from the point of view a potential user of the code. The test later proposed (section 7) is limited to a very simple case with a ~ 3 FWHM cutoff for the convolution. Such task is quickly performed by several other codes and public libraries, as already recognized by the authors (btw, in the introduction a mention to conviqt library: Prezeau G., Reinecke M., 2010, ApJS, 190, 267 is absolutely necessary). It would be interesting to quote performances in a realistic case, e.g. when sidelobes are considered and a more realistic convolution is performed, at least some numbers that can be, even if not absolutely, at least relatively compared. Maybe a table with nside map, nside beam and cutoff.

2. The units of many plots are not very clear, are those C_ℓs or D_ℓs? From EE and BB I would guess Dls, but this is not explicitly written. The y scale for the central plot is the one on the right I guess, but, again, this is not mentioned. The TT spectrum is rather low, below $1000\mu K^2$, why?

3. In general the section 7.2.4 is rather puzzling. The authors want to describe the sub pixel effect, which is due to the realistic pointing of an experiment. This effect has two main consequences. First two samples falling in the same pixel but in different position will have a different measured value, even for a Dirac delta function beam. Second due to the convolution of the beam, even for constant filed in a pixel, the stationarity of the mapmaking is violated, as consequence, for example, the possible mismatch in temperature between different samples will be interpreted as polarization. Now, the authors state that a symmetric distribution of the hits in a pixel will solve this problem, but this only if the field is constant in a pixel, which is not true in a real case. An easy way of simulating that is to start from a very high resolution map, observe (convolve) and repixelize with a mapmaking to a lower resolution. Second point, related to the second mentioned above, why the leakage is only P to P? I really do not understand that. Immagine that I observe a single pixel 3 times, but hitting in different positions, the integral below the beam will be different, combining those three observations I will have any kind of leakages, T -¿ P included. Could the authors explain better what they are doing in this subsection, I agree that probably some effects are hidden by the way the simulation is performed, but the target of the paper should be to show the ability of such tool in simulating realistic effects.

Minor revisions:

1. In the simple validation (section 6) the convolved spectra (smoothing VS PISCO) differ also in temperature at high ell (around $\ell = 200$), why? Maybe here a plot showing a relative difference is more useful that what the authors included.

2. This is minor, but I think it deserves a comment. In light of what mentioned in section 7.2.4, the sentence in section 4.2 *It is worth noting that this expression operates on a pixelated sky, so information at angular scales that are smaller than a sky pixel is lost* is not technically true, since using the actual pointing of the experiment (and not allining each samples with the closest pixel center) preserves some of the sub

pixel information. In other words, for equation 4.5 is worth to mention here that B_k keeps track of the actual position of the beam in the sky.