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Tests of a Novel Technique for Finding Galaxies in Millimeter Wavelength Maps

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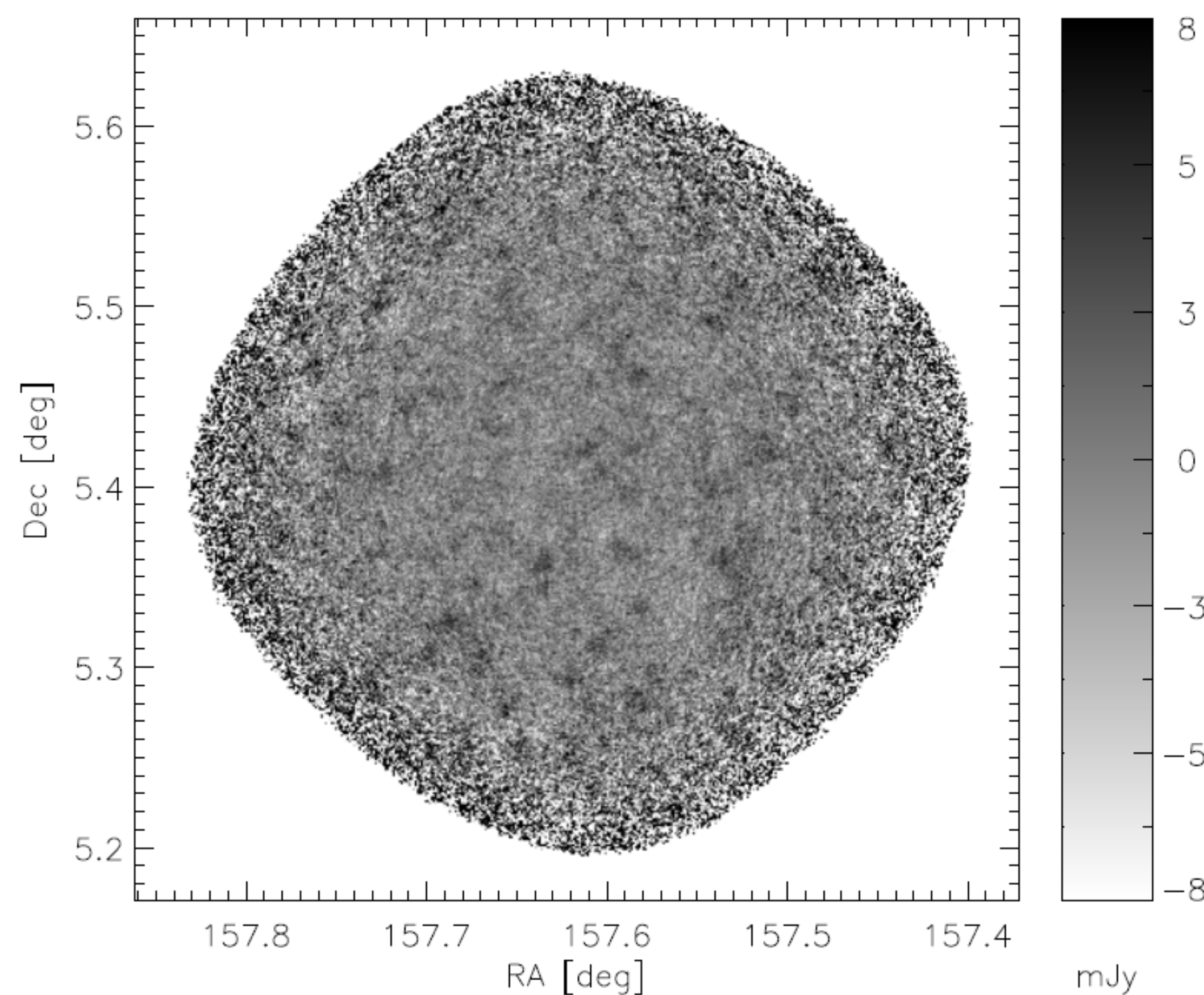
Tests of a Novel Technique for Finding Galaxies in Millimeter Wavelength Maps

Alejandro Mancera and Thushara Perera

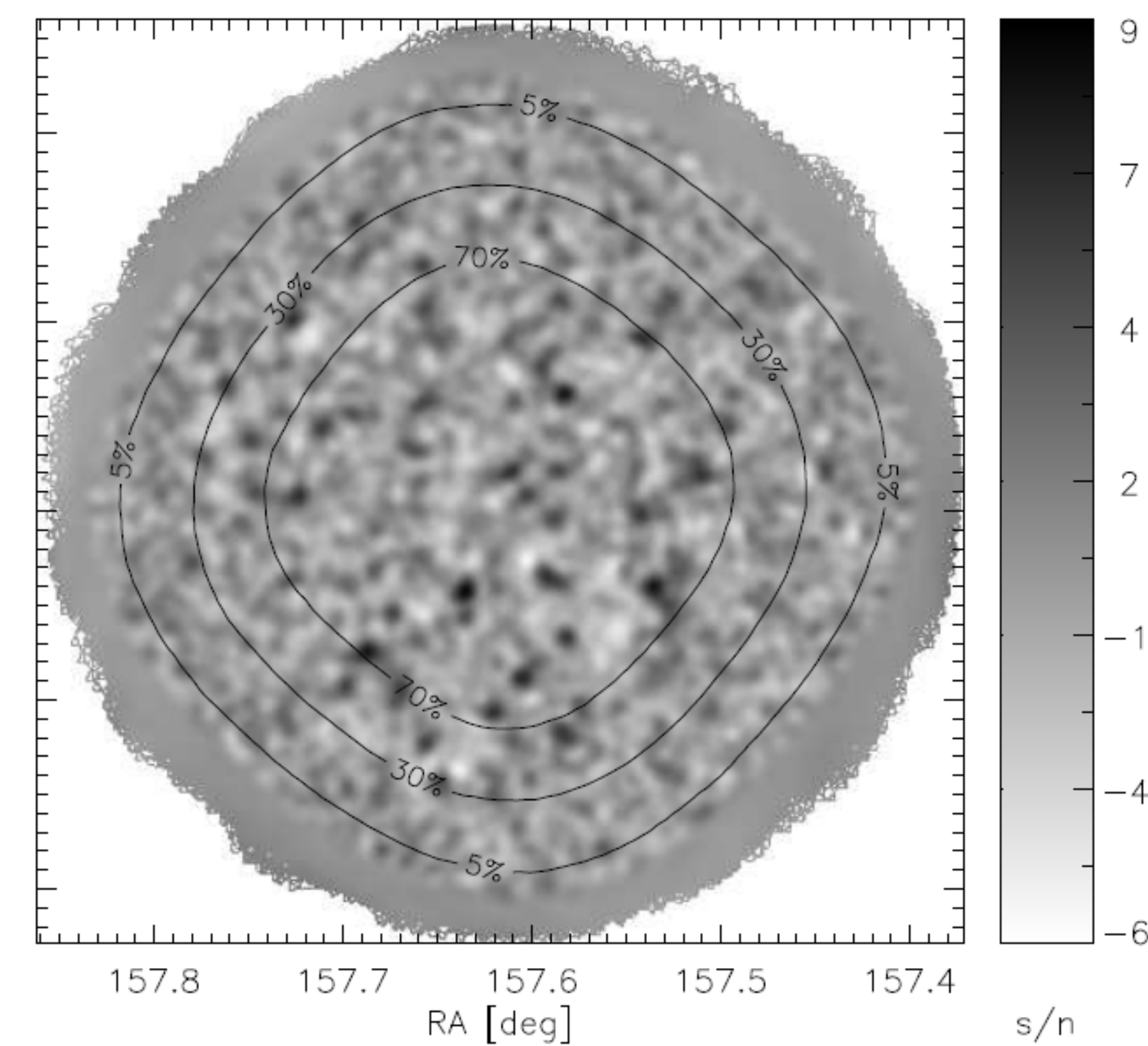


Introduction

The study of very distant “dusty” galaxies whose visible light is obscured by cosmic dust is a developing field in astronomy. To discover such galaxies, images of the sky are made with telescopes sensitive to millimeter-wavelength light. Because these images are inherently low in signal-to-noise, special image processing techniques are needed to reliably identify galaxies in them. Usually, a software “filter” is applied to a sky image in order to better distinguish galaxies from noise. We have developed a novel filter that performs better than the standard filter used in the astronomical community. Our study, which involved testing this new filter, is presented here. This is the culmination of (and improvement over) work previously presented at the JWP 2010.



The figure above shows an example sky map at 1.1mm wavelength, made with the AzTEC instrument, where dark corresponds to high intensity and light to low intensity. The outer edges tend to be very noisy as seen with the large fluctuations in brightness. Even some of the dark spots in the good region are due to noise rather than distant galaxies



Here, a software “filter” developed by us has been applied to the previous map to reliably identify galaxies. The filter

- Treats non-uniform noise levels (high near the borders) fairly to avoid “false detections.”
- Increases the signal/noise reliability of dark spots (potentially galaxies)
- Decreases the overall noise level

This software is an improvement over the standard filter used within the mm-wave astronomy community, which assumes uniform noise levels across the map in order to minimize computation time. The innovation of the new filter is that the complex calculations necessary for treating non-uniform noise are implemented in a computationally efficient way, that requires only ~10% more time to run than the standard filter.

I developed code using IDL to test the degree of improvement in results due to using the new filter

<u>Map Region</u>	<u>Filter A</u>	<u>Filter B</u>	<u>B but not A</u>	<u>A but not B</u>
>70% coverage	31	31	2	2
30-70% coverage	15	18	3	0

Results

Filter A is the novel filter and Filter B is the standard filter. As shown in the table above (for the example field), Filter B detects 5 additional sources that are not really distant galaxies, due to non-uniform noise levels within the field. As expected this effect is more pronounced in the 30-70% border region. Filter B also misses two sources that have higher true signal/noise (last column). Therefore, we conclude that it is beneficial to implement the more intricate calculations of the novel filter, especially since the computation time only increase by ~10%.