RADIO-FREQUENCY INTERFERENCE AND THE mmA

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The mmA should be designed carefully to minimize its sensitivity to radio-frequency interference.

One goal for the mmA is to provide continuous frequency coverage over very wide frequency bands, with individual receivers having bandwidths of 20-30 percent or more. But such bandwidths will include far more than the bands allocated to radio astronomy. I list below selected allocations for satellite-borne transmitters and powerful ground-based or airborne transmitters which fall in the frequency bands planned for the mmA:

30-50 GHz Band:

- 30.0-31.3 GHz Standard Frequency and Time Signal-Satellite (Space-to-Earth) (secondary)
- 33.4-36.0 GHz Radiolocation
- 38.6-40.5 GHz Fixed-Satellite (Space-to-Earth)
- 39.5-40.5 GHz Mobile-Satellite (Space-to-Earth)
- 40.5-42.5 GHz Broadcasting-Satellite
- 45.5-47.0 GHz Radionavigation-Satellite

68-115 GHz Band:

- 66.0-71.0 GHz Mobile-Satellite and Radionavigation-Satellite
- 76.0-81.0 GHz Radiolocation
- 81.0-84.0 GHz Fixed-Satellite (Space-to-Earth) and Mobile-Satellite (Space-to-Earth)
- 84.0-86.0 GHz Broadcasting-Satellite
- 92.0-95.0 GHz Radiolocation
- 95.0-100.0 GHz Mobile-Satellite and Radionavigation-Satellite
- 102.0-105.0 GHz Fixed-Satellite (Space-to-Earth)

130-183 GHz Band:

- 126.0-134.0 GHz Radiolocation
- 134.0-142.0 GHz Mobile-Satellite and Radionavigation-Satellite
- 144.0-149.0 GHz Radiolocation
- 149.0-164.0 GHz Fixed-Satellite (Space-to-Earth)

195-314 GHz Band:

- 190.0-200.0 GHz Mobile-Satellite and Radionavigation-Satellite
- 231.0-241.0 GHz Fixed-Satellite (Space-to-Earth)
- 241.0-248.0 GHz Radiolocation
- 262.0-265.0 GHz Mobile-Satellite and Radionavigation-Satellite

In many cases these allocations are adjacent to those for radio astronomy. As well, many observations of interest will fall outside the allocations for radio astronomy.
While observations in these allocations may be interfered with directly, of equal concern is that signals from licensed users in these allocations will be strong enough to cause gain compression in the mmA receivers or even to damage them. Both HEMT cryoFETs and SIS receivers will be used on the mmA. Generic models of both types of receivers are needed to evaluate their sensitivities to radio-frequency interference. The model of Thompson and Schlecht (1985) for a FET receiver such as used on the VLA or VLBA may be appropriate for the HEMT receivers to be used on the mmA but no model is available for the SIS receivers. Tests indicate that received powers of 1-10 W will damage HEMT receivers. My impression is that HEMT receivers are much less sensitive to gain compression and more robust to damage than are SIS receivers.

Strong signals at adjacent frequencies may create additional problems by generating intermodulation signals during the mixing process from RF to IF frequencies.

The requirements for filtering radio-frequency interference will interact with other requirements such as image suppression (Kerr 1991). Techniques for low-pass, high-pass, bandpass, and notch filters at millimeter wavelengths should be investigated. Cryogenically cooled filters will be used in the Lband receiver at the Fort Davis VLBA antenna; perhaps similar filters can be used with the HEMT receivers on the mmA.

Interference from signals in the IF is a familiar problem at existing mm- and submm-wavelength observatories. The band is 1-2 GHz is commonly used but Kerr (1991) discusses 2-3 GHz and 3-4 GHz and even 20-40 GHz. Unfortunately, licensed transmitters in those bands may be quite strong and/or airborne or on satellites. Some examples are

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Application</th>
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<tbody>
<tr>
<td>1215-1400 MHz</td>
<td>Radiolocation</td>
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<tr>
<td>1530-1559 MHz</td>
<td>Mobile-Satellite (Space-to-Earth)</td>
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<tr>
<td>2310-2360 MHz</td>
<td>Digital Audio Broadcast (Sound) (proposed)</td>
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<tr>
<td>2500-2690 MHz</td>
<td>Broadcasting-Satellite</td>
</tr>
<tr>
<td>3100-3700 MHz</td>
<td>Radiolocation</td>
</tr>
<tr>
<td>3700-4200 MHz</td>
<td>Fixed-Satellite (Space-to-Earth)</td>
</tr>
<tr>
<td>4500-4800 MHz</td>
<td>Fixed-Satellite (Space-to-Earth)</td>
</tr>
<tr>
<td>5250-5925 MHz</td>
<td>Radiolocation</td>
</tr>
<tr>
<td>10700-12200 MHz</td>
<td>Fixed-Satellite (Space-to-Earth)</td>
</tr>
<tr>
<td>12200-12700 MHz</td>
<td>Broadcasting-Satellite</td>
</tr>
<tr>
<td>17700-20200 MHz</td>
<td>Fixed-Satellite (Space-to-Earth)</td>
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Great care will be needed to reduce the potential for such interference.

Kerr, A.R. 1991, "Image Frequency Suppression on the mmA," mmA Memorandum No. 70