**Cryogenic Selective Surfaces—How Cold Can We Go?**

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**The Concept**

A solid sphere of aluminum sitting in deep space at 1 A.U. from the sun. Assuming constant emissivity the sphere will reach an equilibrium temperature of about 280 K (about 42 degrees F). The Earth on average is warmer than this due to greenhouse effects.

Hibbard (1961) showed we could reach 40 K with ideal materials. But real world materials are not ideal. The key question is, Can we reach cryogenic temperatures with a realizable selective surface?

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**First Try- Second Surface Mirrors**

A common selective surface is a second surface mirror, where a material that is transparent in the visible, but dark in the far-IR is placed onto a mirror.

We modelled materials such as sapphire, CaF2, and MgF2 on silver.

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**Second Try- Dielectric Mirrors**

Dielectric mirrors are multi-layer reflectors that have achieved better than 99% reflectivity over bands as large as 300-1100 nm. If we could extend this they might yield the solar reflectance needed to reach cryogenic temperatures.

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**Third Try- Diffuse Scatterers-Solar White**

A third possible cryogenic selective surface is composed of diffuse particles of a material like MgF2 or BaF2. Such a surface would appear white to most of the solar spectrum, i.e. “Solar White.” The images below show the scattering and transmission of an object composed of pure glass fibers when exposed to visible radiation. Nearly all of the light is scattered out of the illumination face.

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**Predicted Temperature Results**

<table>
<thead>
<tr>
<th>Coating Material</th>
<th>Coating Thickness</th>
<th>Sphere Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sapphire</td>
<td>0.2 mm</td>
<td>161 K</td>
</tr>
<tr>
<td>CaF2</td>
<td>2 mm</td>
<td>156 K</td>
</tr>
<tr>
<td>MgF2</td>
<td>4 mm</td>
<td>153 K</td>
</tr>
</tbody>
</table>

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**Likely Failure**

Might succeed under substantial funding, but high risk of failure.

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**Theoretical Success!**

A Selective Surface that reaches Cryogenic Temperatures!

Now we can move on to applications.