Impact to the Radio Astronomy by the Interference caused by the Solar Power Satellite Systems

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Summary

Interference with radio astronomical observations, which have several protected bands near the planned SPS frequencies (2.45 or 5.8 GHz) or their harmonics, is of particular concern for the radio astronomers. Radio astronomy has historically increased its sensitivity, and in the next decade, major initiatives will enhance the sensitivity by a factor of 100. All possible measures need to be taken to protect the radio astronomical observations. The above frequencies are designated as the ISM (industry, science, and medical) and applications such as microwave ovens and wireless LANs in the Radio Regulations of the International Telecommunication Union (ITU). It is mandatory that unwanted emissions – such as carrier noise, harmonics, and spurious and out-of-band emissions of the microwave power-transmission beams – are suppressed sufficiently to avoid interference with other radio services and applications, in accordance with the ITU-R Radio Regulations. It would be a big engineering challenge for the SPS. Although the intended bandwidth of the SPS emissions is quite narrow (it is an essentially monochromatic wave without modulation will be used), spurious and out-of-band emissions generated by microwave power-transmission beams could be distributed in wide frequency range unless the spectral purity is low.

Astronomical Radio Quiet Zones (RQZs) are currently in the process of being implemented in isolated areas in, e.g., Australia, China, and South Africa. This is being done to ensure the regulatory protection of next-generation giant radio telescopes against detrimental manmade radio interference over wide frequency ranges, based on interference threshold levels recommended by the ITU. Currently, regulatory control over the RQZs applies only to ground-based transmissions. However, for the zones to be effective, it is important that they are not exposed to harmful levels of emissions from space. Even when an SPS is operating entirely within its permitted frequency range, with no out-of-band transmissions, the power transmitted within its sidelobes may still be harmful to the operation of broadband radio telescopes in RQZs (and elsewhere). An additional challenge will therefore be to devise solutions to prevent unwanted interference from the SPS into such facilities.

The apparent angular size of a solar-cell array of 10 km² is close to 1 arc minute (somewhat larger than the angular size of Jupiter), and scattering of unwanted radiation in the atmosphere would substantially extend the affected region. This means that even optical astronomy would be affected in an extended region of the sky, particularly if a large number of SPS units were operational. The substantial loss of observable sky resulting from these wideband emissions (optical, UV, infrared, and radio) needs to be carefully considered. Furthermore, the passive thermal radiation of the solar cells of a large number of SPS units is expected to make a substantial zone of the sky, centered on the geostationary orbit. The sky area would be unusable for astronomical observations at essentially all frequencies. This would occur even when the microwave transmission of the SPS towards the Earth was not operational.