Array Gain Loss Due to Fixed Low-Frequency Antennas

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One of the properties of an array composed of fixed-pointed elements, such as FASR-C and the LWA, is that the gain, or effective collecting area will be a function of position in the sky because of the primary pattern of the basic array element. This brief memo presents two plots of the array element gain as a function of hour angle for the sun at summer solstice, the equinoxes, and winter solstice plus the declination of the galactic center.

In Figure 1 the elements are pointed to the zenith, and Figure 2 is for elements pointed to the intersection of the celestial equator and the meridian. The array's geographic latitude is assumed to be +34 degrees. The antenna element power pattern is taken to be circularly symmetric with the relative gain, in dB, given by

$$P = 10.0 * log_{10}(cos(\theta)^{1.7}) \tag{1}$$

where θ is the angular distance from the antenna axis. This pattern has a gain of -2.6 dB at 45^o, -3.3 dB at 50^o, -5.1 dB at 60^o, which is fairly representative of a dipole over ground or a low-gain log-periodic dipole array.

Since the type of array antenna element chosen for FASR-C or the LWA may depend on whether its pattern is directed toward the zenith or not, the users of these two arrays should evaluate the scientific merits of the two options presented and discuss them with the antenna designers. Zenith-pointing antennas are probably easier to construct, hence, cheaper for frequencies below 100 MHz, but the cost differences have yet to be explored. More complex options, such as two fixed antennas pointed on either side of the meridian can be computed on request.

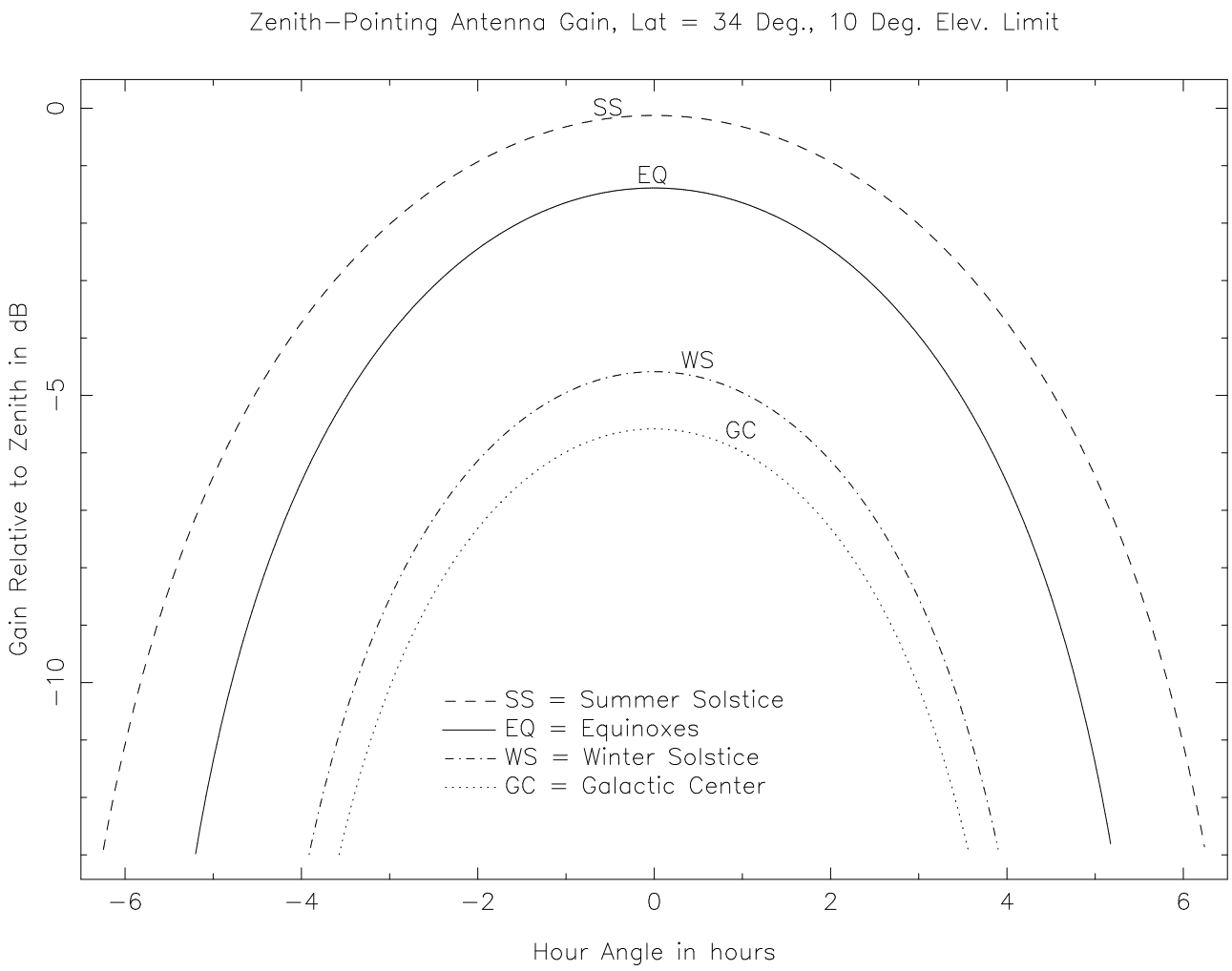

Fig. 1.— Hour-angle dependence of antenna gain for a fixed, zenith-pointing array antenna element at the declinations of the summer solstice, equinoxes, winter solstice, and galactic center.

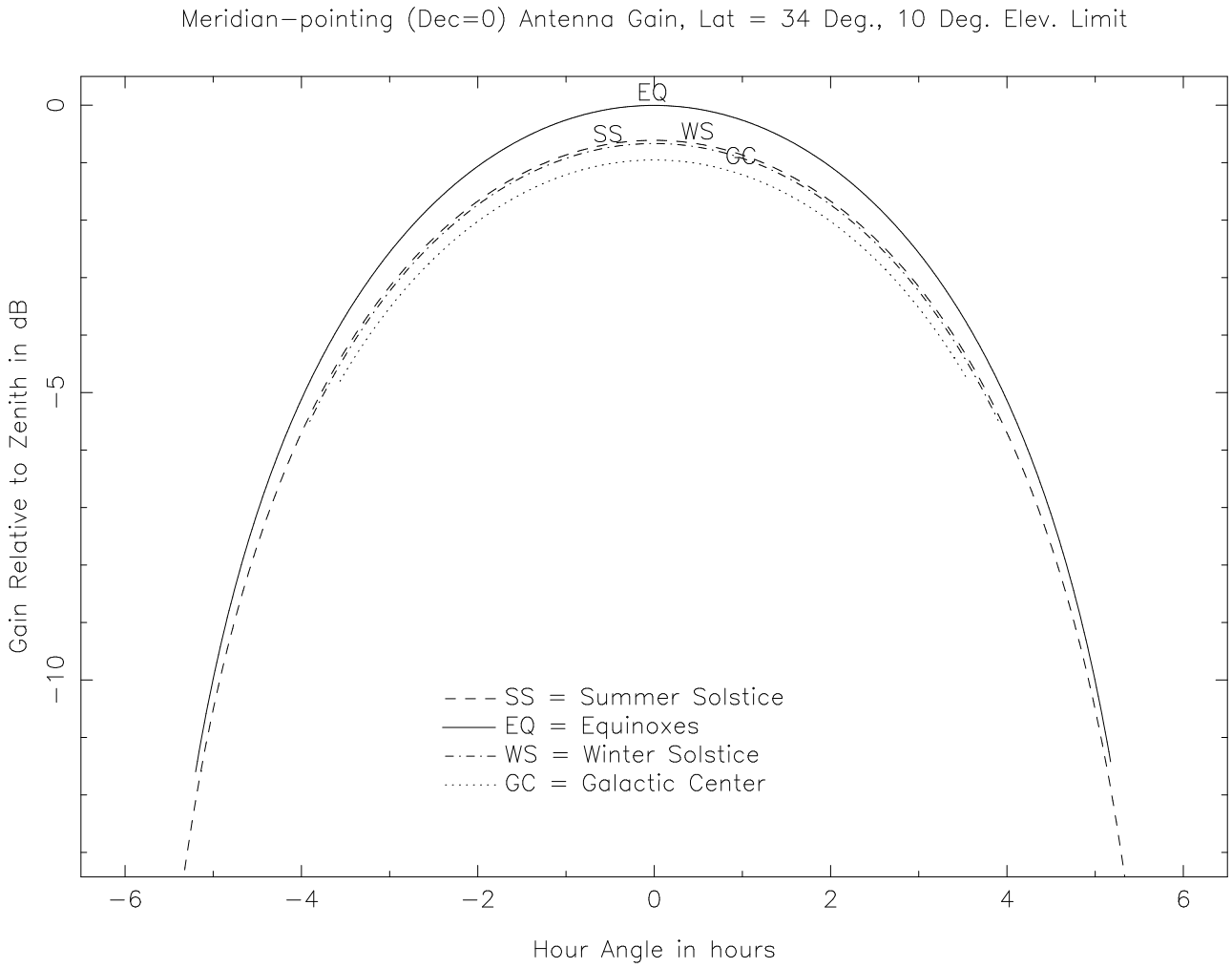

Fig. 2.— Hour-angle dependence of antenna gain for a fixed, array antenna element pointed toward the intersection of the celestial equator and the meridian at the declinations of the summer solstice, equinoxes, winter solstice, and galactic center. Note that the summer solstice gain at large hour angles is substantially lower than it is for the zenith-pointing antenna.