Homology and the Position of the Arm.

A. R. Thompson

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The desirability of maintaining some degree of homology in the gravitational deflections of an unblocked-aperture antenna has a bearing upon the question of whether the focal-point support arm should be at the top or botton of the main reflector. This consideration, which I believe has not previously been raised in NRAO studies, emerged in a discussion following a talk on plans for the GBT that I gave at MPIFR in Bonn on Sept. 26.

Consider a dish-shaped structure pointing upwards. In most practical designs the effect of gravity will be to cause the dish to sag in a way that tends to open the aperture and increase the focal length. Similarly, if the dish were pointing vertically downwards it would tend to close. If the dish is moved in elevation between these two positions, the point at which the effect of gravity changes sense, i.e. changes between tending to open and tending to close the dish, is when the perimeter of the dish lies approximately in a vertical plane. This statement should be true for either a symmetrical or an unblocked design. The point that was brought out in the discussion mentioned above is that it is likely to be difficult to maintain homology in the structure as the antenna is moved through the elevation angle at which the gravitational effect reverses. For a symmetrical antenna this reversal occurs when the beam is pointing at one end of the useful elevation range, i.e. towards the horizon, so the reversal problem hardly arises. For an unblocked antenna with the arm at the top, the dish perimeter never becomes vertical as the beam goes from the horizon to the zenith. However, for an unblocked design with the arm at the bottom, the reflector is close to the vertical for an elevation angle of about 26 degrees (for f/D = 0.6).

Although the GBT will rely more on the active surface than on homology for maintaining the ultimate surface accuracy, it is desirable that the gravitational deviations from a parabolic surface remain as small and predictable as possible so that the active corrections can be accurately determined. In addition to linear deformations, any hysteresis in the structure would be likely to appear at the angle at which gravitational effects are reversed, thus exacerbating the situation. With the arm on the bottom, there could therefore be an increase in the rate of change of shape of the dish with elevation angle in the vicinity of 26 degrees, resulting in increased difficulty in maintaining the best surface accuracy. Such an elevation angle would be encountered during observations of sources located over a large part of the accessible sky.

The arguments outlined above are purely qualitative, but seem intuitively reasonable and potentially important. When a practical design is available, a structural analysis should show whether in fact they are significant. For the present, the use of the arm-on-the-top configuration for design studies seems to be a good choice to have made.