(3) 90-GHz Radiometer

Figure 3 shows the 90-GHz (0.33-cm wavelength) radiometer configuration. In 1982 the 90-GHz radiometer topology was similar to that of the 33-GHz radiometer with the two antennas pointed in opposite directions; they now point 60° apart. This change improves the measurements of the atmospheric antenna temperature, $T_{A,atm}$, which places by far the most serious limitation on the CBR measurement at this frequency. Because the radiometer can be moved quickly from one position to another, little time is lost while the position is reset, so rapid measurements of the atmosphere can be made at several zenith angles. The radiometer configuration has the additional advantage that the zenith angles observed by the antennas during atmospheric measurements are determined only by the orientations of the antennas themselves and do not depend on the flatness and orientation of a reflector. Since an accurate measurement of $T_{A,atm}$ at 90 GHz requires with which the zenith angles be known to a few arcminutes, the ease and accuracy that the zenith angles can be measured in this configuration leads to more precise measurements of $T_{A,atm}$ and T_{CBR} (Witebsky, 1985).

During measurements of the zenith temperature both antennas point down, one antenna looks into the cold load while the other views the zenith by means of a reflector. The radiometer, which is mounted on bearings, is then rotated by 60° to reverse the roles of the two antennas and thereby remove the effects of radiometer offset. The atmospheric antenna temperature, $T_{A,atm}$, is obtained from observations at multiple zenith angles. The radiometer is rotated to point the antennas upward and stepped through a series of angles which cause the north antenna to view the sky at zenith angles of 50°, 40°, 20°, and 10° to the north of the zenith while its southern partner observes the complementary zenith angles 10°, 20°, 40°, and 50° south. Observations to the north and south are combined to remove radiometer offset and to reduce the effect of large-scale gradients in atmospheric humidity. Gain-calibration and data-recording techniques are much the same as those used with the 33-GHz radiometer. The lock-in amplifier has a two-second integration period, each pair of targets is observed for either 16 or 32 seconds, and a measurement cycle, consisting of observations of the zenith and cold load, a gain calibration, and a set of atmospheric measurements, takes 192 seconds.

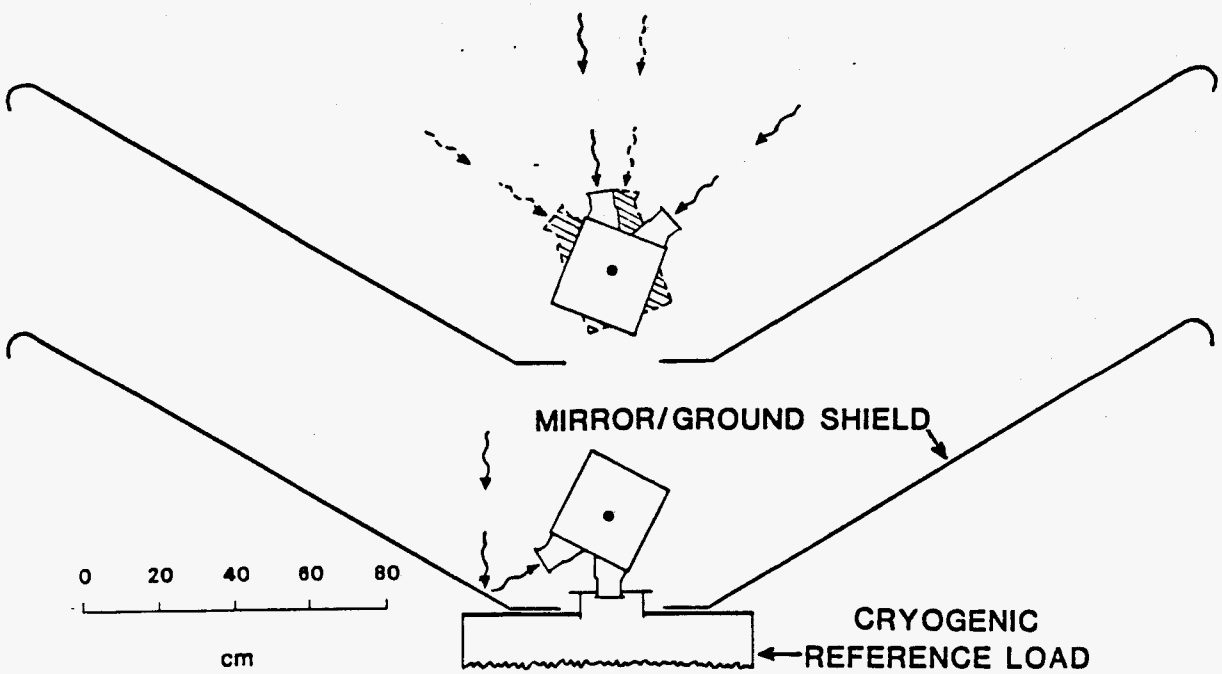

Figure 3. 90-GHz radiometer geometric configuration. (Top) To measure atmospheric emission one antenna points near the zenith (10° here) while the other antenna points to a larger zenith angle (50°) . The radiometer rotates to the symmetric position (shaded).
(Bottom) In sky-versus-cold-load measurements, one antenna views the cold load directly while the other observes the zenith in reflection. The radiometer rotates 60° counter-clockwise to reverse the roles of the two antennas.