EXTREME SCATTERING EVENTS

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Abstract. Daily flux density measurements of 36 extragalactic radio sources over a seven year period, obtained by the Green Bank interferometer, reveal several unusual minima in the light curves that do not follow typical source variations (Fiedler et al. 1987). The most significant departure from typical source variability occurred at both frequencies in the quasar 0954+658 between 1980.95 and 1981.3. Refractive focussing by small scale inhomogeneities in an ionized structure in the interstellar medium appears to be the most likely explanation.

Unprecedented flux density variations have been observed in the radio light curves of 0954+658, 1502+106, and 1611+343. These sources are all between 40 and 50 degrees galactic latitude. The best case, 0954+658, is illustrated in Figure 1 where the data is plotted for the entire 7-year observing interval. It is clear from the figure that the typical variations of 0954+658 bear no relation to the event between 1980.95 and 1981.3.

The unusual variations appear to be indicative of an occultation event. The rapid decline of the 2.7 GHz flux density just prior to the period of low, constant flux, and the subsequent rapid rise together with a VLBI angular size (Pearson and Readhead 1981) provides information on the proper motion of the occulter relative to the line of sight. The proper motion is estimated to be 0.09 mas/day and implies a transverse velocity of 500c at the quasar. We consider as unlikely the possibility that the occulter is local to the source, or at a cosmological distance.

An occulter that is local to our galaxy with a transverse velocity $v < 200$ km/s seems more likely. When combined with the estimated proper motion we obtain a distance limit of $D < 1.3$ kpc. From the duration of the minimum we estimate an upper limit to the scale sizes of the 2.7 GHz footprint, at the earth. The velocity

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and the duration of the prolonged minimum, about 60 days, give s < 7 AU. This dimension should be comparable to the physical size of the occulter.

The irregular fluctuations observed at 8.1 GHz and the more regular variations at 2.7 GHz may be explained using refractive effects through irregularities in ionized gas density in the occulter. The estimated upper limit to the ionized particle density is 4000 cm^{-3}. If the irregularities are extended along the line of sight, then the density can be much lower.

Three events observed spanning 395 days in about 160 source-years implies a number density of 120 pc^{-3} f^{-1}, if the occulters are a halo population objects. This is about 1000 times the number density of stars in the galactic disk. The dimensionless factor, f, is included to allow for the possibility that the occulters may be filamentary, and is the ratio of the linear extent to the width.

Clearly, the nature of these objects still needs to be elucidated by observations of additional events.

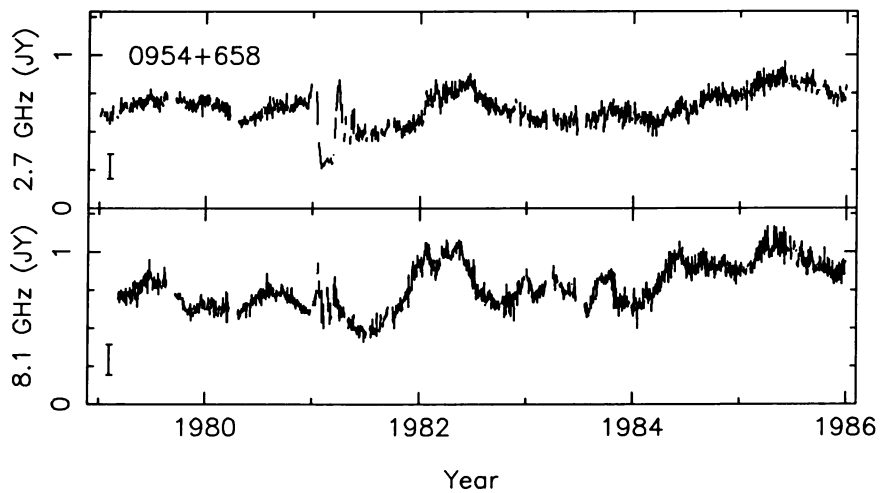

Figure 1. The 2.7 and 8.1 GHz flux densities of the quasar 0954+658 are plotted from 1979 through 1985. The error bars are twice the rms error in height. The unusual variations in the light curves between 1980.95 and 1981.3 may be an extreme scattering event caused by the passage of a cloud in our own galaxy across the line of sight to the quasar.

References:

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