MAGNETIC FIELDS IN YOUNG SNRS

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There are two very important properties of the magnetic fields in supernova remnants which we wish to emphasize: 1) The net radial orientation of the magnetic vectors throughout the shell and 2) an apparent gradual increase in the fractional polarization with evolutionary age.

The first feature has been well reported observationally (see e.g. the results on Tycho's SNR by Dickel, van Breugel and Strom in this volume) but no complete theoretical explanation of the appropriate stretching phenomenon exists. The magnetic field strength of about 10^{-4} gauss is too great to be caused by simple compression of the ambient field alone and also the compression at the shock front should produce a tangentially oriented field rather than the radial one. If the expanding shell is driven into a clumpy surrounding medium, the interfaces will be Rayleigh-Taylor unstable and convective fingers will develop to stretch the field in a net radial direction, as originally suggested by Woltjer (1972) and Gull (1973). Because the fractional polarization is small (5-10% in the historical remnants) most of the field remains random on a very small scale and only about 3% of the overall field goes into the ordered component. The turbulence caused by the flow will amplify the overall magnetic field and an efficiency of about 1% for conversion of turbulent into magnetic energy is sufficient to provide the needed field.

As a remnant ages, the overall expansion will be slowed by the accumulation of swept up matter but the convective flow will continue to stretch the field and the fractional polarization may rise with time. Such an effect can be seen observationally in the data plotted in Figure 1 (from the references below). Because the true physical age is known for only a very small number of SNRs we have used the decrease of radio surface brightness at 1 GHz as a relative age indicator. For a given explosion energy and uniform interstellar parameters the surface brightness after an initial turn on, has a dependence of about $\text{time}^{-0.6}$ (Dickel et al. 1989). While many factors, such as the sweeping up of regions of uniform interstellar fields will affect the evolution of the fractional polarization, the stretching parameters is one which behaves in the desired manner. The solid lines in Figure 1

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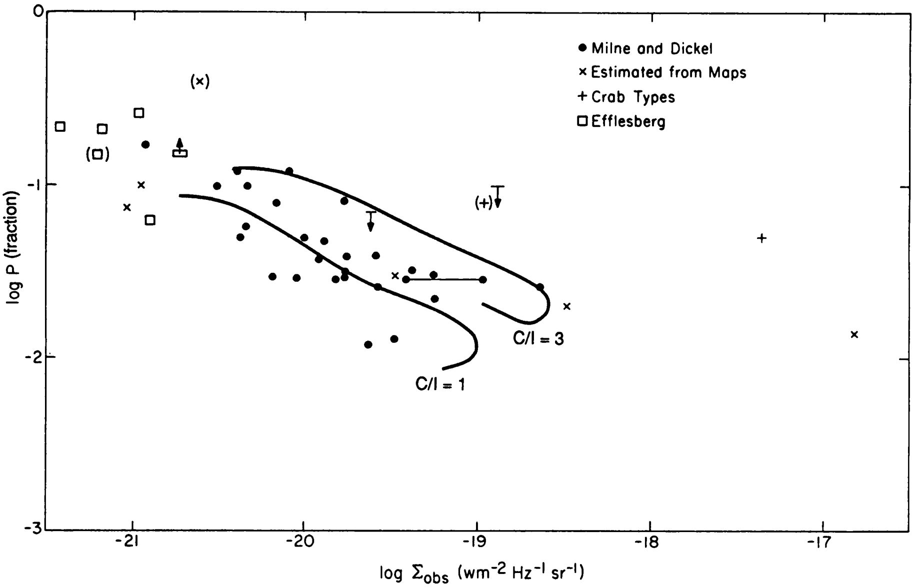

Fig. 1. Fractional polarization at 5 GHz as a function of 1 GHz surface brightness. Surface brightness decreases with age.

show the evolution of the fractional polarization calculated by a numerical hydrodynamic code for two different representative ratios of the contrast between the clump and interclump material in the circumstellar medium. Better understanding of the phenomenon must await a fuller evaluation of the detailed field structures in older remnants.

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