14.07 A Model for Extragalactic Variable Radio Sources. P. A. STUBRICK, Stanford U.

A model for extragalactic variable radio sources was proposed some time ago by Shklovsky (Nature, 206, 176 [1965]) and developed further by Van der Laan (Nature, 211, 1131 [1966]). This model assumes an isotropically expanding plasmoid containing a fixed amount of magnetic flux and an isotropic distribution of relativistic electrons which evolves adiabatically during the expansion. At any time during the expansion, the radio flux has a maximum value $S_{\nu}(t)$ at some frequency $\nu(t)$. According to the Shklovsky-Van-der-Laan model, these quantities should be related by $S_{\nu} = \nu^{n}$, where $n = (7 + 5)/(4n + 5)$, where $n$ is the radio spectral index in the optically thin part of the spectrum, where $S = \nu^{-\alpha}$. For $n$ in the range 0.5 to 1.3, we therefore expect $n$ to be in the range 1.21 to 1.41.

Observational studies summarized and analysed by Andrew et al. (AJ, 83, 863 [1978]) show that $n$ falls in a small range about the mean value 0.4, in clear contradiction to the Shklovsky-Van-der-Laan model.

I have reconsidered the above model, relaxing the assumptions that the expansion is isotropic and that the electron distribution remains isotropic. One of these modifications yields an estimate of $n$ which is compatible with observational data.


Recent radio observations of extended extragalactic jets have indicated that they often possess magnetic field configurations which are not axisymmetric. We suggest that these configurations could correspond to the MHD equilibrium states of magnetic-pressure dominated, super-Alfvénic jets which are confined laterally by the pressure of the surrounding medium. Specifically, we argue that the magnetic field in such jets is likely to be force-free and satisfy the relation $\Phi = \mu \delta$, with $\mu$ a constant. Specializing to a cylindrical geometry, we demonstrate that the minimum-energy configuration will in general be a mixture of an axisymmetric ($m=0$) mode and a nonaxisymmetric ($m=1$) mode of wavelength $\approx \lambda$, where $\lambda$ is the radius of the jet. The amplitudes of these modes will be determined by the values of the conserved magnetic flux and helicity in the jet, as well as by the external pressure. In particular, a jet which carries little net axial flux will be dominated by the $m=1$ mode. We point out a number of observed features in jets which can be interpreted within this picture—including the lateral oscillations of the central ridge line with wavelengths $\approx \lambda$, the oscillations of the peak intensity and degree of polarization along the ridge line, and the overall distribution of the polarization position angles.

14.11 Active Galaxies and the Diffuse $\gamma$-ray Background. D. Kazanas, GSC, MD., R. J. Protheroe, University of Adelaide, Australia.

A new model for the origin of relativistic particles and $\gamma$-rays in active galactic nuclei and quasars, together with recent HEAO 1 observations of the spectra of active galaxies from 2 to 165 keV, provides the basis for the present re-examination of the nature of the extragalactic $\gamma$-ray background. We report here that active galaxies could account for the observed background if their X-ray spectra steepen to $E^{-2.1}$ above ~100 keV, as has been observed in Cen-A, together with a further steepening to $E^{-2.7}$ as a result of absorption of $\gamma$-rays by photon-photon pair production interactions with X-ray photons. The compactness of active galaxies required to give this steepening is consistent with current estimates of their typical luminosity and radius.


A detailed analysis of the distributions of optical and radio synchrotron radiation in the spiral galaxy NGC 3310 has been made at 1st resolution (100 pc) in order to determine possible sources of cosmic ray electrons. The results indicate that the synchrotron emission correlates best with the spiral arms of the galaxy, as defined by Hydrogen alpha line radiation. The enhancement of synchrotron eminivity in the arms relative to the disk, is found to be $\sim 100$. In addition, a study of the dynamical data reveals a correlation between the synchrotron eminivity along the arms and the associated shock velocity. The latter is defined as the rotational velocity minus the pattern velocity.

We have attempted to model the results with the following compression and injection scenarios. (a) Adiabatic shock compression by a density wave accounts for the observed dependence of synchrotron eminivity on the shock velocity. However, it fails to account for the amount of arm to disk enhancement. (b) Isothermal (dissipative) shock compression can match the observed enhancement but fails to reproduce the velocity dependence. (c) Discrete sources of cosmic rays, such as supernova remnants and pulsars, were considered. Too many are required to account for the amount of observed emission. Furthermore, cosmic rays propagate too slowly in star forming regions to establish the extended eminivity present in the arms. (d) Cosmic ray acceleration by the shock via turbulent scattering (Bell, 1978) predicts a velocity dependence that is consistent with the observations and easily accounts for the arm to disk enhancement.

15.02 A Galactic Disk is not a True Exponential. P.E. SKIDEN, IBM, L.S. SCHULMAN, Tech.-Israel Instr. Tech., and B.G. EMEGREEN, Columbia U. - Stochastic self-propagating star formation predicts that the distribution of atomic hydrogen in a galactic disk should be relatively independent of radius. The molecular hydrogen should therefore vary as the total.

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