14.04

Hydrodynamic Cooling Effects in Expanding Ionized Nebulae

A. Frank (U. Wash.)

Models of the ionization and line emissivities of H II regions and planetary nebulae do not consider hydrodynamic cooling of the nebulae. In this paper we describe a "cooled wind": a spherically symmetric ionized flow in which expansion cooling can dramatically alter the expected temperature distribution of expanding nebulae.

Our calculations use the full Euler equations, including an energy equation that incorporates heating by photoelectrons and cooling through recombination, (parameterized) forbidden-line radiation, and expansion of the outward flowing gas. For flows with stellar mass loss rates below 10^{-7} $M_{\odot}$ y^{-1} this hydrodynamic cooling can reduce the temperature below 5000 - 1000 °K at radii where expansion cooling of the gas exceeds radiative cooling rates.

In many cases the outer parts of wind-driven nebulae are too cold for the excitation of forbidden lines to be effective. Consequently, interpretations of line ratios in which temperatures are simply assumed (as opposed to measured), as is likely when the [O III]λ4363 line escapes detection, are likely to derive chemical abundances that are anomalously low and inconsistent from values derived from brighter parts of the same nebula.

14.05

Observational Limits on Hydromagnetic Turbulence Ahead of Shocks in Supernova Remnants

S. P. Reynolds (North Carolina State U.), R. D. Blandford (Caltech)

Diffusive shock acceleration theory demands upstream scattering of particles if they are to be turned around to recross the shock and be accelerated. The distribution of accelerated particles should decline rapidly with distance in front of the shock. If the edge of supernova-remnant (SNR) radio emission marks a shock wave at which electrons are accelerated, the sharpness of that edge sets an upper limit on the diffusion length of relativistic electrons, which implies a lower limit on the amplitude of the Alfvén turbulence presumably responsible for the scattering. This limit is strongly dependent on the shock obliquity angle $\theta_{\rm Bn}$, the angle between the shock normal and upstream magnetic field. Since this angle is in general unknown at a given point on a projected SNR circumference, the lower limit is probabilistic, and depends on the angle of the external magnetic field, presumed roughly uniform, to the line of sight. We show that for parameters typical of high-resolution VLA observations of SNRs, limits can be inferred of order $\delta B/B > 1\%$ or more, for turbulence on the scale of radio-emitting electrons' gyroradii (about 10^{13} cm). This level is much higher than typically inferred for the undisturbed interstellar medium. Specifically, 5 GHz VLA observations of W49 B (Moffett 1990), with a resolution of 4″, show that about 1/2 the perimeter is unresolved, with intensity levels dropping by a factor of about 6 on average from the edge to the external noise level. This implies a lower limit to $\delta B/B$ of 6%, if $\theta_{\rm Bn} = 0$ at such an edge; even if $\theta_{\rm Bn} = 60°$ there, $\delta B/B > 0.7\%$. For the remnant SN 1006 observed at 1.4 GHz, the lower limit ranges from 0.2% if $\theta_{\rm Bn} = 60°$ to 1% if $\theta_{\rm Bn} = 0$. Such levels of turbulence presumably result from counterstreaming energetic ions and electrons; thus this inference provides evidence for a crucial part of the diffusive shock acceleration scheme.

Moffett, D. A. 1990, master's thesis, NCSU Physics Department

14.06

Non-Equilibrium Ionization in Three Regions of Puppis A

K. Flanagan (SAO)

X-ray emission lines from the Puppis A supernova remnant were observed with the FPCS of the Einstein Observatory. The lines examined are predominantly from helium-like and hydrogen-like ions of neon and oxygen, and neon-like ions of iron. The ratios of the measured line fluxes provide useful diagnostics of conditions in the line-emitting plasma. These diagnostics constrain the electron temperature, T_e, hydrogen column density, N_H, and ionization age $n_e t$ (where n_e is the electron density and t is the time since passage of the shock).

Three regions of the remnant are examined in detail: the interior, the shock front, and a bright knot of emission in the east. Despite the advanced age of the remnant (4000 years), none of the three regions is found to be in equilibrium. Diagnostics for the bright knot are consistent with a single plasma in the temperature range of 3 - 5 X 10^6 K, far from ionization equilibrium. The emission lines from the interior suggest spatial separation of oxygen and neon.

Session 15: Large Scale Structure and the Cosmic Microwave Background
Oral Session, 10:00–11:30 am
Cascade II

15.01

COBE's FIRAS: Update on Refining Measurements of the Cosmic Microwave Background Radiation Spectrum

E.S. Cheng, J.C. Mather, R.A. Shafer (NASA/GSFC), D.J. Fixsen (USRA), R.E. Eplee, Jr., R.B. Isaacman (GSC), S. Read (STX), S.S. Meyer, R. Weiss (MIT)

A complete set of raw data has been collected for the Far Infrared Absolute Spectrophotometer instrument on the COBE. This data set covers the entire sky roughly 1.5 times, and reflects the duration of the cryogenic operations period of the spacecraft.

The details of the instrument calibration are now understood in terms of a self-consistent model which fits all the on-orbit calibration data. The accuracy of such a model in the 3 to 20 cm^-1 frequency region is discussed, together with the residual effects which may require further correction. Preliminary results from using this improved calibration are presented.

15.02

Limits on Cold Dark Matter Models from Recent Anisotropy Measurements of the Cosmic Background Radiation

P. Lubin, P. Meinhold, T. Gaier, J. Gunderson (University of California Santa Barbara)

Recent measurements from several balloon borne and South Pole experiments on anisotropy in the background radiation will be presented. The experiments cover an angular range of ten arc minutes to ten degrees using a variety of both coherent and incoherent detector technologies. Sensitivity at or below $\Delta T/T \sim 10^{-5}$ has been achieved. Future work is actively being pursued with a goal of 10^{-6} sensitivity. These measurements already critically con-