STUDYING THE FORMATION AND EVOLUTION OF GALAXIES AND CLUSTERS WITH GAMMA-RAYS AND COSMIC RAYS

SUSUMU INOUE
Division of Theoretical Astrophysics, National Astronomical Observatory

Abstract

High energy, nonthermal phenomena are invaluable probes of shock heating processes crucial to the formation and evolution of large scale structure in the universe, and should offer new insight into studies of galaxies, groups/clusters and the intergalactic medium. Here we mainly discuss the following two subjects.

1) **HEATING OF INTRACLUSTER GAS BY POWERFUL RADIO GALAXIES AND ASSOCIATED GAMMA-RAY EMISSION FROM HIGH-ENERGY ELECTRONS (Inoue & Sasaki 2001).**
High-power radio galaxies are shown to be prime candidates for the non-gravitational heating sources necessary to reproduce the observed X-ray scaling relations of groups and clusters. This scenario is directly testable by observing the 'prompt' inverse Compton gamma-rays emitted by electrons shock accelerated during the heating epoch, e.g. by GLAST.

2) **COSMIC RAY SYNTHESIS OF ^{6}Li BY STRUCTURE FORMATION SHOCKS IN THE EARLY MILKY WAY GALAXY (Suzuki & Inoue 2001).**
It is shown that the ^{6}Li abundances observed in metal-poor halo stars, which are difficult to explain with production mechanisms involving supernovae, can be naturally accounted for by cosmic rays accelerated at shocks in merging sub-Galactic clumps during hierarchical structure formation of the Galaxy. Combined with stellar kinematics information, future observations of ^{6}Li, e.g. by the Subary HDS, may offer us a precious fossil record of dissipative gas dynamical processes in the formation history of the Milky Way.

Inoue, S. & Sasaki, S. 2001, ApJ, 562, 618
Suzuki, T. K. & Inoue, S. 2001, in prep. for ApJ Lett.