OVER-LUMINOUS ELLIPTICAL GALAXIES

NASA Grant No. NAG5-12931

Annual Report #2

For Period 1 March 2004 through 28 February 2005

Principal Investigator
Dr. William Forman

December 2004

Prepared for:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this Grant is Richard Mushotzky, NASA/GSFC Code 662
Greenbelt, MD 20771

The first paper from our work has been completed and accepted for ApJ. Since the last report we have modified our first draft and responded to the referee. Our paper (ApJ 612, 80) presents a study of the ESO 3060170 galaxy group, combining Chandra, XMM-Newton, and optical observations. We find that the system is a true fossil galaxy group - a group whose optical light is dominated by a single galaxy. The group X-ray emission is composed of a central, dense, cool core (10 kpc in radius) and an isothermal medium beyond the central 10 kpc. The region between 10 and 50 kpc (the cooling radius) has the same temperature as the gas from 50 to 400 kpc, although the gas cooling time between 10 and 50 kpc (2-6 Gyr) is shorter than the Hubble time. Thus, the ESO 3060170 group does not have a group-sized cooling core. We suggest that the group cooling core may have been heated by a central active galactic nucleus (AGN) outburst in the past and that the small, dense, cool core is the truncated relic of a previous cooling core. The Chandra observations also reveal a variety of X-ray features in the central region, including a ``finger," an edge-like feature, and a small ``tail," all aligned along a north-south axis, as are the galaxy light and group galaxy distribution. The proposed AGN outburst may cause gas to ``slosh" around the center and produce these asymmetric features. The observed flat temperature profile to 1/3rvir is not consistent with the predicted temperature profile in recent numerical simulations. We compare the entropy profile of the ESO 3060170 group with those of three other groups and find a flatter relation than that predicted by simulations involving only shock heating, S~r~0.85. This is direct evidence of the importance of non-gravitational processes in group centers. We derive the mass profiles within 1/3rvir and find that the ESO 3060170 group is the most massive fossil group known.

The group is part of the thesis (Harvard University) of M. Sun who is the first author of the paper. As part of the thesis, the unique properties of the group are being compared to those for a sample of other relaxed groups and clusters to better understand the unique features including its temperature and entropy profiles.