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# M31* and its circumnuclear environment



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Abstract

We present a multiwavelength investigation of the circumnuclear environment of the Andromeda galaxy (M31), utilizing archival *Chandra*, *FUSE*, *GALEX, HST* and *Spitzer* data as well as ground-based observations. Based on the *Chandra*/ACIS data, we tightly constrain the X-ray luminosity of M31*, the central supermassive black hole (SMBH) of the galaxy, to be $L_{0.3-7\ \mathrm{keV}} \lesssim 1.2 \times 10^{36}$ erg s$^{-1}$, approximately one part per $10^{10}$ of the Eddington luminosity. From the diffuse X-ray emission, we characterize the circumnuclear hot gas with a temperature of ~0.3 keV and a density of ~0.1 cm$^{-3}$. In the absence of an active SMBH and recent star formation, the most likely heating source for the hot gas is Type Ia supernovae (SNe). The presence of cooler, dusty gas residing in a nuclear spiral has long been known in terms of optical line emission and extinction. We further reveal the infrared emission of the nuclear spiral and evaluate the relative importance of various possible ionizing sources. We show evidence for interaction between the nuclear spiral and the hot gas, probably via thermal evaporation. This mechanism lends natural understandings to (1) the inactivity of M31*, in spite of a probably continuous supply of gas from outer disc regions and (2) the launch of a bulge outflow of hot gas, primarily mass-loaded from the circumnuclear regions. One particular prediction of such a scenario is the presence of gas with intermediate temperatures arising from the conductive interfaces. The *FUSE* observations do show strong O viλ1032 and λ1038 absorption lines against the bulge starlight, but the effective column density, $N_{\rm O\ VI} \sim 4 \times 10^{14}\ {\rm cm}^{-2}$, may be attributed to foreground gas located in the bulge and/or the highly inclined disc of M31, leaving the amount of circumnuclear gas with intermediate temperatures largely uncertain. Our study strongly argues that stellar feedback, particularly in the form of energy release from SNe Ia, may play an important role in regulating the evolution of SMBHs and the interstellar medium in galactic bulges.

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