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THE ABSORPTION AND EMISSION SPECTRUM OF RADIATIVE COOLING GALACTIC FOUNTAIN GAS

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ABSTRACT

We have calculated the time-dependent, nonequilibrium thermal and ionization history of gas cooling radiatively from 10^6 K in a one-dimensional, planar, steady-state flow model of the galactic fountain, including the effects of radiative transfer. Our previous optically thin calculations explored the effects of photoionization on such a flow and demonstrated that self-ionization was sufficient to cause the flow to match the observed galactic halo column densities of C IV, Si IV, and N V and UV emission from C IV and O III] in the constant density (isochoric) limit, which corresponded to cooling regions homogeneous on scales $D \gtrsim 1$ kpc. Our new calculations which take full account of radiative transfer confirm the importance of self-ionization in enabling such a flow to match the data but allow a much larger range for cooling region sizes, i.e. $D_0 \gtrsim 15$ pc. For an initial flow velocity $v_0 \sim 100$ km/s, comparable to the sound speed of a 10^6 K gas, the initial density is found to be $n_{H,o} \sim 2 \times 10^{-2}$ cm^{-3}, in reasonable agreement with other observational estimates, and $D_0 \sim 40$ pc. We also compare predicted Ha fluxes, UV line emission, and broadband X-ray fluxes with observed values. One dimensional numerical hydrodynamical calculations including the effects of radiative cooling are also presented.

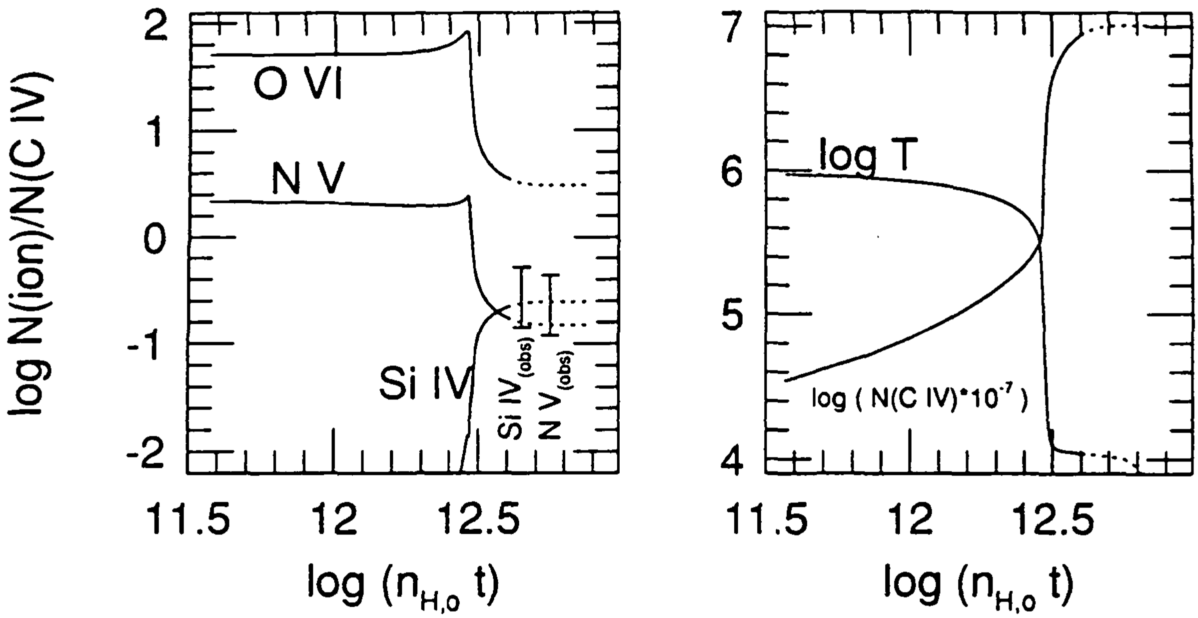

Fig. 1 — (Left panel) Column density ratios N(N V)/N(C IV), N(Si IV)/N(C IV), and N(O VI)/N(C IV) versus ($n_{H,o}t$) (cm^{-3} sec) for a case with D_0=40 pc, v_0=100 km/s, and $n_{H,o}=1.6 \times 10^{-2}$ cm^{-3}. Evolution is stopped at the 10^4 K temperature "plateau" stage, when the cooling time becomes much longer than a sound crossing time. Dotted line indicates further evolution if the pressure in this stage remains fixed at the value of the internal pressure of the cooling region at the end of the isochoric, rapid cooling phase. The observed range for the column density ratios is indicated by vertical bars. (Right panel) Plot of temperature and log (10^{-7}N(C IV)) for the same case.