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Atomic Chemistry in Turbulent Astrophysical Media

Evan Scannapieco[1], William J. Gray[2] and Daniel Kasen[3]

[1]School of Earth and Space Exploration, Arizona State University, P.O. Box 871404, Tempe, AZ 85287-1494, USA
email: evan.scannapieco@asu.edu

[2]Lawrence Livermore National Laboratory, P.O. Box 808, L-038, Livermore, CA 94550, USA
email: gray58@llnl.gov

[3]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA
email: kasen@berkeley.edu

Abstract. We decribe direct numerical simulations of turbulent astrophysical media exposed to the redshift zero metagalactic background. The simulations assume solar composition and explicitly track ionizations, recombinations, and ion-by-ion radiative cooling for hydrogen, helium, carbon, nitrogen, oxygen, neon, sodium, magnesium, silicon, and iron. Each run reaches a global steady state that not only depends on the ionization parameter, U, and mass-weighted average temperature, $T_{\rm MW}$, but also on the the one-dimensional turbulent velocity dispersion, $\sigma_{\rm 1D}$.

We carry out runs that span a grid of models with U ranging from 0 to 10^{-2} and $\sigma_{\rm 1D}$ ranging from 12 to 58 km s^{-1}, and we vary the product of the mean density and the driving scale of the turbulence, nL, which determines the average temperature of the medium, from $nL = 10^{16}$ to $nL = 10^{20}$ cm^{-2}. The turbulent Mach numbers of our simulations vary from $M \approx 0.5$ for the lowest velocity dispersions cases to $M \approx 20$ for the largest velocity dispersion cases. When $M \lesssim 1$, turbulent effects are minimal, and the species abundances are reasonably described as those of a uniform photoionized medium at a fixed temperature. On the other hand, when $M \gtrsim 1$, dynamical simulations such as the ones carried out here, are required to accurately predict the species abundances.

We gather our results into a set of tables, to allow future redshift zero studies of the intergalactic medium to account for turbulent effects. They are available at
http://zofia.sese.asu.edu/ evan/turbspecies/ and will be updated as we increase our parameter study. These results are explained in more detailed in Gray, Scannapieco, & Kasen (2015), and Gray and Scannapieco (2015)

Keywords. Turbulence, ISM: atoms, ISM: abundances

References

Gray, W. J., Scannapieco, E., & Kasen, D. 2015, *ApJ*, 801, 107
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