Models for the End of the Dark Age

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Abstract: After the Big Bang the Universe cooled down and all matter recombined. Except for cosmic background photons, the radiation level was extremely low. This situation changed, when the first stars (or possibly the first accretion disks around Black Holes) lit up. The emitted photons ionize larger and larger parts of the interstellar and intergalactic gas around the sources. The speeds with which the ionisation fronts proceed depend in a very complicated way on the local density, ionisation state, distance from the source(s) and history. In the present Universe most regions are ionised so that—due to resulting low opacity—large fractions are accessible to observations. For the modeling we solve simultaneously the time-dependent, multidimensional radiative transfer equation and the time dependent rate equations for the atomic levels considered. The time dependencies have to be taken into account explicitly because of the large distances involved and because ionisation and recombination, the inverse process, have very different time scales. Since in addition the medium is very inhomogeneous, the resulting system becomes very stiff. In the contribution first a short overview of the cosmological context will be given. We then discuss the equations governing the propagation of the ionising radiation and the fast algorithm (a fully implicit scheme that exploits the fact that light rays are straight lines in these situations) we are using for its solution. We illustrate the resulting physics by means of one-dimensional models and finally show the 3D evolution of the ionisation and of the visibility in the Universe as they result from present-day cosmological models.

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