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GASEOUS GALACTIC HALOES AND LYα ABSORPTION LINE SYSTEMS

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Abstract. This thesis studies various aspects of the intragalactic origin theory for a large fraction of Lyα absorption line systems observed in spectra of all known QSOs. We have approached this long-standing problem along several different lines, with underlying assumption of the basic unity of physical processes relevant to the structure and evolution of the baryonic content of the universe. A new wave of interest in galactic origin of Lyα forest absorption systems has recently been sparked by observational determination of the extent and structure of extended gaseous haloes of luminous galaxies, and is yet far from being exhausted.

After the introductory review, containing some cosmological background, a didactic discussion on the basic properties of Lyα forest is presented along with necessarily laconic overview of existing theoretical models for the origin of these absorption lines. The former are placed in their natural historical context, and several of their physical properties, necessarily subjectively chosen, have been considered in detail in order to illuminate major building blocks of any viable theoretical model of the QSO absorption line origin. A critical assessment of the relevant literature in the field is given, together with some remarks of the historical and epistemological nature pertaining to the topic.

The second Chapter gives an overview of different arguments and lines of reasoning leading to conclusion that very extended gaseous haloes of normal galaxies are responsible for both metal and hydrogen (mainly Lyα) lines seen in QSO spectra. The foremost emphasis is put on arguments based on redshift coincidences, the absorber-absorber (auto)correlation function and the total absorption cross-section of luminous galaxies. It is shown that the best available compilation of Lyα absorption lines is consistent with the halo model, where the contribution to the amplitude of the autocorrelation function of Lyα clouds is to be found on velocity scales $\Delta v \leq 200$ km s^{-1}. These velocity scales are the characteristic of intragalactic motions, and are supposed to correctly describe velocity dispersion of an ensemble of halo clouds in the two-phase gaseous halo model. This model is developed in subsequent sections, along with various alternatives for explaining the empirical data.

Another set of arguments for the plausibility of gaseous halo model is based on the galaxy counts and inferred redshift surface densities in the deep fields like the *Hubble Deep Field.* Redshift surface densities, recently obtained through the photometric redshift techniques, enable us to calculate the total absorption cross-section of luminous galaxies up to the given redshift, and compare it to empirical results obtained from established absorption-line statistics. It is shown that the early structure formation, resulting in high deep number counts, leads naturally to a large gaseous cross-section, invalidating one of historically crucial arguments against the galactic halo origin of absorption lines, namely that the total galactic cross-section is too small for reproducing observed absorption line density. The implication is *not* that the entire Lyα forest is produced by galaxies, but only that it is difficult to avoid a substantial absorption in galaxies, especially at redshifts less than $z \simeq 2$, where the total

absorption cross-section is huge.

Cosmological mass fraction contained in the Lyα absorbing gas and the feasibility of directly detecting absorbing halo gas in recombination emission are two topics discussed in the central part of the present study. It is shown that the two-phase galactic halo model, with appropriate clumping, enables the low-redshift baryonic census to stay firmly within the primordial nucleosynthesis bounds. In other words, the gaseous galactic halo picture is entirely free from any need to fine-tune the ratio of metagalactic ionizing flux to the total baryonic cosmological density, J_{ν_0}/Ω_B, unlike some of the models of inhomogeneous IGM. Halo clouds containing this mass may well be visible in Hα emission in the low-redshift window with the existing technology, through either long-slit spectroscopy or Fabry-Perot imaging. This is, undoubtedly, one of the most exciting opportunities of modern observational cosmology.

Huge gaseous envelopes of galaxies are also investigated from the point of view of their interaction with environment in form of an ambient intergalactic medium (IGM). Arguments for essential isolation of gaseous content of field galaxies at later epochs are presented before certain concluding remarks on the structure and evolution of the baryonic dark matter.

A number of closely related topics is treated briefly in the Appendices. Among them are molecular abundances in high-z damped Lyα systems, rotation of young galactic disks and contribution of MACHO objects, recently detected in Galaxy's halo through gravitational microlensing searches, to the cosmological baryonic density. These interrelated issues help us to place previously discussed physical processes into an emerging framework relating to a unified description of evolution of baryonic content of our universe.

One of the main conclusions is that all observational data gathered so far are in compliance with the picture of two populations of physical objects causing Lyα absorption in QSO spectra: a diffuse, unclustered population of primordial IGM inhomogeneities, dominant at high redshift and the lowest column densities; and population of clouds residing in gaseous haloes of luminous galaxies dominant at low- and intermediate-redshifts and in the higher column density regime. The gradual transition between these two populations represents a major evolutionary event in the history of the gaseous content of the universe. Another lesson learnt in the course of the present work, is that while unraveling the puzzles of the baryonic matter evolution in the universe we need an interdisciplinary approach which will connect seemingly unrelated fields of physics and astronomy into a coherent picture of structure and evolutionary development of the matter as we know it.