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"On the theory of radiation and collision processes in a magnetoactive astrophysical plasma" (by PhD thesis)

We analyze electron-ion collisions and solve problems concerning cyclotron and synchrotron radiation transfer in astrophysical plasma. The obtained results are important for detection of coranae around white dwarfs, for diagnostics of magnetospheres of magnetic degenerate stars, and for search of cosmic synchrotron masers.

1) We analyze electron-ion collisions in a case of strong magnetic field when an electron gyroradius is less than the typical parameter corresponding to the close collisions in the absence of magnetic field (the Rutherford parameter). Such a condition realizes in photospheres of magnetic white dwarfs. In that case we obtain the electron-ion collision term under classical approximation of the electron motion. We calculate the transport collision frequency that describes kinetic energy equipartition over parallel and transverse to magnetic field degrees of freedom. This frequency is one of the key parameters in the cyclotron radiation transfer equations.

2) We calculate a critical temperature of photosphere of magnetic white dwarf, corresponding to the case where the cyclotron radiation force per one electron exceeds the gravitational one. A correct expression for the collision frequency in a magnetized plasma on white dwarfs is taken into account. A substantial decrease of the collision frequency in a strong magnetic field leads to the growth of the critical temperature up to 40 000 K. Possible variants of plasma ejection from the photosphere into magnetosphere are discussed.

3) We calculate a frequency spectrum and polarization of the cyclotron emission by the corona of the isolated magnetic white dwarf G 99-47. We show that corona cyclotron emission at the first and second cyclotron harmonics exceeds an intensity of photospheric continuum at the same level. The calculated spectra are compared with the photometric measurements of G 99-47 in $K$, $L$ and $L'$ filters of the infrared band. The wavelengths of these filters cover all the frequency interval of the second cyclotron harmonic. In the result, we obtain the upper limits $10^6$ K and $10^{10}$ cm$^{-3}$ on the temperature and electron density in the corona. These limits are substantially less than the limits obtained from the X-ray observations of G 99-47.

4) We develop a quasilinear theory of the cosmic synchrotron maser emission in the saturated regime. We obtain a frequency spectrum and the level

of the outgoing radiation from the lengthy source where synchrotron maser mechanism realizes. We point out the characteristic features of the frequency spectrum that identifies cosmic synchrotron maser. We give examples of the astrophysical sources which spectra indicate on the possible realization of the synchrotron maser mechanism in these objects.