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On the Strong Scott Conjecture in the Chandraskehar Model

We consider large neutral atoms of atomic number Z. For such atoms the speed of electrons close to the nucleus is a substantial fraction of the speed of light c. Thus, a relativistic description is necessary. We model the atom by the pseudo-relativistic Hamiltonian of Chandrasekhar.

Our main result is the convergence of the suitably rescaled one-particle ground state density in each angular momentum channel: it converges on distances $1/Z$ from the nucleus to the corresponding density of the one-particle hydrogenic Chandrasekhar operator. This proves a generalization of the strong Scott conjecture for relativistic atoms.

The proof uses the Scott correction, i.e., the two term expansion of the ground state energy (Solovej, Sørensen, and Spitzer and Frank, Siedentop, and Warzel), and a new equivalence of Sobolev norms generated by the free and the hydrogenic Chandrasekhar operators.

The result underscores that relativistic effects occur close to the nucleus and that self-interactions of the innermost electrons are negligible.