A Linear Scaling Space-Charge Routine using Wavelets, P. KNAUS, CERN + TERA FOUNDATION - The present paper focuses on a method to solve Poisson's equation in a wavelet basis. It outlines an efficient discretisation of the discontinuous charge distribution by automatically customising the computational mesh. This is done by adding wavelets of the next higher level of resolution if their coefficients are above a certain threshold. For the presented algorithm, the CPU-time scales linearly with the number of mesh points. Moreover, it allows non-uniform grids and does not require any symmetry of the particle distribution. The motivation for developing the wavelet technique for space-charge simulations in synchrotrons arose from the need to understand the influence of discontinuous charge distributions during multi-turn injection into the CERN PS Booster. The particle distribution during injection is smooth almost everywhere, except for small regions with sharp discontinuities caused by beam loss on the injection septum. Such locally discontinuous functions have sparse representations in a wavelet basis allowing fast computations. Furthermore wavelets allow the detailed examination of the steep gradient regions without causing computational overheads elsewhere. Finally, as the beam distribution evolves in time and loses its discontinuities, the analysing wavelet may be dynamically changed to best match the new situation.