Non-singular Green’s functions for the unbounded Poisson equation in one, two and three dimensions

In this paper, we derive the non-singular Green’s functions for the unbounded Poisson equation in one, two and three dimensions using a spectral cut-off function approach to impose a minimum length scale in the homogeneous solution. The resulting non-singular Green’s functions are relevant to applications which are restricted to a minimum resolved length scale (e.g. a mesh size) and thus cannot handle the singular Green’s function of the continuous Poisson equation. We furthermore derive the gradient vector of the non-singular Green’s function, as this is useful in applications where the Poisson equation represents potential functions of a vector field.