The true advantage of the spectral method is that the eigenvalues and eigenvectors of the integral operator provide valuable insight into the dielectric behavior of clusters of biological cells. The eigenvectors are a measure of surface charge distributions due to a field. Only eigenvectors with a non-zero dipole moment contribute to the polarizability of the particle. We call these dipole-active eigenmodes. An effective separation of the geometric and morphologic properties from dielectric properties is therefore achieved [16]. We also show that for a particle covered by multiple confocal shells, the relaxation spectrum is a sum of Debye terms with the number of relaxations equal to the number of interfaces times the number of dipole-active eigenvalues. This is a generalization of a previous result [17] on cells of arbitrary shape.

Our method is related to another spectral approach which uses an eigenvalue differential equation [18–21]. This method has been applied to biological problems by Lei *et al.* [22] and by Huang *et al.* [23]. These authors, however, considered homogeneous cells with much simpler expression for cell polarizability. The BIE spectral method seeks a solution on the boundary surface defining the particle, as opposed to the eigenvalue differential equation, where the solution is defined in the entire space.

In a previous study on double (budding) cells it was shown that before cells separation an additional dispersion occurs [24]. Moreover, in recent papers [3, 25] numerical experiments have shown that the dielectric spectra of a suspension of dimer cells connected by tight junctions exhibit an additional, distinct low-frequency relaxation. Our numerical calculation shows that the largest dipole-active eigenvalue approaches the value of 1/2 as the junction become tighter. Although the coupling of this eigenmode with the electric field stimulus is relatively modest (the coupling weight is about 1-2 %), this eigenmode has a significant contribution to the polarizability of clusters. Thus the eigenmodes close to 1/2 induce an additional low-frequency relaxation in the dielectric spectra of clustered biological cells even though the coupling is quite small. Needle-like objects, such as elongated spheroids or long cylinders, have similar polarizability features.

In this paper we consider rotationally symmetric linear clusters made of up to 4 identical particles covered by thin insulating membranes and connected by junctions of variable tightness. Convenient and flexible representations for the surfaces describing these objects are provided. The number of relaxations in the dielectric spectrum of the linear clusters, their time constants and their relative strengths are analyzed in terms of the eigenmodes of