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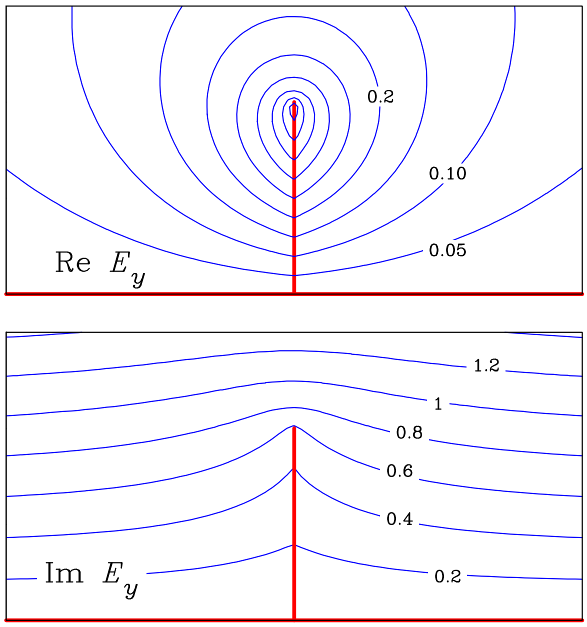
Research Interests: Inverse theory, geomagnetism, spectral analysis, electromagnetic induction.

Bob Parker has continued to study theoretical problems in electromagnetic induction. After the horizontally or radially layered systems, the simplest electrical structures to understand are 2-dimensional. Then the magnetotelluric (MT) induction problem naturally decomposes into two modes, one in which the driving magnetic field is parallel to the lineation, Transverse Magnetic (TM) induction, the other where the field is perpendicular to it, Transverse Electric (TE) induction. In his recent work (ref 1 below), Parker investigates TE in a degenerate structure comprising conductors that are extremely thin compared to their width, a model often used for representing the oceans in large-scale modeling, or for fluid-filled cracks and rifts. He discovers a large class of such conductors with a strange property: the electromagnetic response possess a single (imaginary) resonant frequency. The response, defined as the $E_x/\mathrm{i}\omega B_y$, of every known 2-dimensional system until now, exhibited infinitely many such resonances.

In the well-understood 1-dimensional inverse problem for MT, conductivity profiles with finitely many resonances play a central role, and they too consist of thin layers embedded in an insulator. Although mathematical analysis the 2-dimensional inverse problem is almost completely lacking, there is reason to believe that best-fitting models may also be built from thin conductors with a finite number of resonances, so that the new class of solutions to the TE induction problem could play a part in a fully-developed 2-dimensional inverse theory.

Another role for these models is in validating numerical codes, which are at present almost our sole means of exploring induction in dimensions higher than one. Thin layers represent a considerable challenge to finite difference and (to a lesser extent) finite element programs. Exact solutions for the new models are readily found using analytic functions of complex variables.



The diagram above gives contours of E, where the electric field into the page is $E_y(x, z, t) = E(x, z)\,\mathrm{e}^{i\omega t}$, around a simple 2-dimensional system of conductors, shown in red. The base is a perfect conductor and the thin vertical conductor has a specially designed conductance profile, $\tau(z) = a\tau_0/(a^2 - z^2)^{½}$ that yields a single resonance for this geometry. The contours are also lines of magnetic force.

Recent Publications

Parker, R. L., New analytic solutions for the 2-D TE mode MT problem, *Geophys. J. Internat.,* doi:10.1111/j.1365-246X.2011.05091.x 186, pp 980-6, 2011.

Van Beuskom, A. E., Parker, R. L., Bank, R. E., Gill. P., E., and Constable, S. The 2-D magnetotelluric inverse problem solved with optimization, *Geophys. J. Internat.,* doi:10.1111/j.1365-246X.2010.04895.x 184, pp 626-38, 2010.