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Fredholm determinants, Evans functions and Maslov indices for partial differential equations

The Evans function is a well known tool for locating spectra of non-self-adjoint differential operators in one spatial dimension widely used to detect stability and instability of traveling and standing waves. A major unsolved problem in many spatial dimensions is to construct its analogue, that is, a function whose zeros and poles would correspond to the eigenvalues of the respective PDE operators. In this work joint with G. Cox and A. Sukhtayev we construct a *multidimensional* analogue of the Evans function as the modified Fredholm determinant of a ratio of Dirichlet-to-Robin operators on the boundary. This gives a tool for studying the eigenvalue counting functions of second-order elliptic operators that need not be self-adjoint. We discuss relations between the spectra of the non-self-adjoint elliptic multidimensional differential operators and nonlinear Robin-to-Robin, Robin-to-Dirichlet, and Dirichlet-to-Robin operator pencils. In the self-adjoint case we relate our construction to the Maslov index, another well known tool in the spectral theory of differential operators. This gives new insight into connections between the Evans function and the Maslov index, allowing us to obtain crucial monotonicity results for the Maslov index.