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Nonlinear eigenvalue problems with applications to quantum systems

Differential equations with negative-power nonlinearities are encountered in physical models more and more often, most notably in the context of micro- and nano-systems. At the same time, this type of nonlinearity typically does not yield easily to the traditional methods of analysis. In this talk I will discuss nonlinear eigenvalue problems of the type

$$\lambda\, Df = f - \frac{1}{f},$$

where D stands for a linear operator. I will demonstrate that for a number of special operators D — e.g. one may take $D = \partial_s^2$, acting in the space of Dirichlet series — the stated problem can be adequately interpreted and fully resolved. In particular, I will discuss an algorithmic method for constructing the complete set of solutions. The resulting eigenfunction bases are applicable as a foundation for specialized signal processing, particularly in the context of magnetic quantum- and nano-systems. I will also point at some conceptual connections with the Number Theory. Finally, I will discuss opportunities for generalizing these results.