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Novel approach to gyrokinetic-Maxwell eigenvalue problem

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In fusion plasmas, multiple branches of drift-wave eigenmodes co-exist. Thus, detecting subdominant modes (specifically, modes only slightly less unstable compared to the dominant mode) is important for plasma discharge and scenario analysis, particularly in relevance to burning plasmas. Typical gyrokinetic initial value solvers are well-suited to capture dominant branches only, being unable to detect subdominant and stable branches of drift-wave eigenmodes and becoming prohibitively expensive in situations when dominant and subdominant mode growth rates are comparable. Conventional gyrokinetic eigenvalue solvers either employ large gyrokinetic response matrices [1] or are based on Maxwell dispersion relations [2]. Both such approaches become more complicated in the presence of collisions, which therefore makes them less suitable for routine analysis of the H-mode tokamak pedestal regions.

CGYRODMD is a novel post-processing tool developed to decompose a complex time series associated with the gyrokinetic-Maxwell system into a set of modes via spectral analysis. It provides a new and powerful approach to recover gyrokinetic drift-wave eigenmodes based only on the solution of the gyrokinetic-Maxwell initial value problem with almost *no added cost* to a typical initial value solver. CGYRODMD is numerically efficient, even on a single CPU. In addition, it sets no restrictions on the plasma geometry, beta (ratio of the thermal to magnetic energy), collisionality and the form of the collision operator. Furthermore, it allows one to accurately resolve modes of comparable growth rates.

The CGYRODMD performance has been tested for conventional tokamak plasmas, as well as for more comprehensive cases in a shaped tokamak geometry. This work has been submitted for publication, and was supported by US DOE under DE-FG02-95ER54309 and DE-SC0024425 (FRONTIERS SciDAC-5 project).

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References
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