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Nonmodal growth and the magnetorotational dynamo instability[1]

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Unravelling the important dynamo processes in magnetized rotating shear flows remains fundamental in understanding turbulent transport in astrophysical disks. We consider the dynamo of the magnetorotational instability (MRI) in its simplest possible form, studying the unstratified shearing box without a mean magnetic field. Despite the lack of spectral instability, sustained turbulence and dynamo is possible in this system, with the non-normality of the linear operator playing an important role. An analysis of the MRI from this non-normal perspective has proved enlightening, illustrating that the fastest growing non-axisymmetric disturbances are very different from the eigenmodes, invariably resembling waves shearing with the background flow (shear waves). With the goal of understanding the core dynamo process, we evolve an statistical ensemble of shear waves in a quasi-linear version of the shearing box system. Among the most interesting ideas resulting from this approach is the existence of a mean field dynamo instability of homogenous background turbulence. The instability saturates at levels consistent with fully nonlinear turbulence simulations and depends strongly on magnetic Prandtl number.

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