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Identification of Amplified Scales Under Opposition Control Through Modal Analysis[1] SIMON TOEDTLI, BEVERLEY MCKEON, Caltech — The opposition control scheme is a proportional feedback control law with unit gain (e.g. Kim Choi, J Fluid Mech, 2017). Recent studies suggest that a constant controller gain applied to all scales, which are described here as Fourier modes, results in a mixed controller performance in spectral space: some modes are attenuated, while others are amplified (e.g. Toedtli et al, IJHFF, 2020) and the observed drag change is the result of a competition between suppressed and amplified scales. Drag reduction can presumably be improved if the amplified scales are either not controlled, or if the gain for those modes is changed so as to result in suppression. In this study, we review a formulation of opposition control in Fourier space and show that the phase of the complex controller gain determines which scales are amplified or attenuated. We further show that for a given controller gain, there is a strong correlation between presence of an amplified eigenvalue in the temporal eigenspectrum of the linearized Navier-Stokes operator and amplification of the corresponding scale in the full nonlinear system. This suggests that modal analyses offer a computationally cheap tool to (at least) identify amplified scales. Implications for active and passive flow control will be discussed.

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