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**Extremal Black Holes in Dynamical Chern-Simons Gravity** LEO STEIN, Caltech, ROBERT MCNEES, Loyola University Chicago, NICOLAS YUNES, Montana State University — Analytic solutions are rare and precious in general relativity, even more so in theories beyond GR. From them we can calculate observational signals of beyond-GR physics, but also learn about the analytic structure of theories, which can't be done with numerics. Despite over a decade of searching, nobody has yet succeeded in finding an analytic form for a generically rotating black hole in dynamical Chern-Simons gravity (dCS), the simplest beyond-GR theory which includes a parity-odd interaction. In this talk we present progress towards a full solution by considering the extremal limit. We treat dCS in the decoupling limit, taking corrections as small perturbations away from GR. We perturb about extremal Kerr, and develop mathematical insight into the techniques needed to construct solutions for general spin. We find closed-form analytic expressions for the scalar field and a formal solution for the trace of the metric deformation, both in Legendre series. The first three (four) modes of the series of the scalar (metric trace) suffice to ensure a fidelity of over 99% relative to numerical solutions. The monopole of the metric trace contains a logarithmic divergence at the extremal Kerr horizon, which is likely hidden behind the perturbed dCS horizon.

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