

I describe work with Stefan Hollands that establishes a general criterion for the dynamical stability of black holes and black branes in arbitrary spacetime dimensions with respect to axisymmetric perturbations. We show that the positivity of the canonical energy on a subspace of linearized solutions that have vanishing linearized ADM mass and angular momentum implies mode stability. Conversely, failure of positivity of canonical energy on this subspace implies instability in the sense that there exist perturbations that cannot asymptotically approach a stationary perturbation; furthermore, failure of positivity on a solution that can be written as the time derivative of another solution implies exponential growth. We further show that positivity of canonical energy is necessary and sufficient for thermodynamic stability (maximum of area at fixed mass and angular momentum) and is also equivalent to the satisfaction of a local Penrose inequality. For black branes, we show that a sufficient condition for instability is the failure of the Hessian of area with respect to mass and angular momentum to be negative, thus proving a conjecture of Gubser and Mitra. Our methods can be applied quite generally to diffeomorphism covariant theories derived from a Lagrangian.