

Critical Phenomena in Gravitational Collapse

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Critical Phenomena - the appearance of universal scaling laws and critical exponents in the vicinity of phase transitions - appear in different fields of physics and beyond. Critical phenomena in gravitational collapse to black holes were first observed by Matt Choptuik about 25 years ago - a seminal discovery that launched an entire new field of research. Until recently, however, most numerical work in this field was restricted to spherical symmetry and - with some notable exceptions - could not account for effects that break this symmetry. In particular, critical phenomena in the gravitational collapse of vacuum gravitational waves - which cannot be spherically symmetric - remain mysterious to this day, even 25 years after they were first reported. In this talk I will review the appearance of scaling laws and self-similarity close to the onset of black hole formation. I will then present new numerical relativity simulations of gravitational collapse to black holes in the absence of spherical symmetry. I will discuss different effects of the absence of spherical symmetry, and will speculate whether our notion of criticality needs to be expanded when the critical solution cannot be spherically symmetric.