"The origins of type Ia supernovae" by Hagai Perets (Technion)

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Type Ia supernovae (SNe) are thought to originate from the thermonuclear explosions of carbon-oxygen (CO) white dwarf (WD) stars. They produce most of the iron-peak elements in the universe, and bright type Ia SNe serve as important “standard candle” cosmological distance indicators. The proposed progenitors of standard type Ia SNe have been studied for decades, and can be, generally, divided into explosions of CO WDs accreting material from stellar non-degenerate companions (single-degenerate; SD models), and those arising from the explosive interaction of two CO WDs (double-degenerate; DD models). However, current models for the progenitors of such SNe fail to reproduce the diverse properties of the observed explosions, nor do they explain the inferred rates and the characteristics of the observed populations of type Ia SNe and their expected progenitors. In the talk I'll discuss new results from our studies on the little explored mergers of CO-WDs with hybrid Helium-CO (He-CO) WDs. We find that such He-enriched mergers give rise to double detonations, first catalyzed by Helium and the second in the carbon-oxygen core of the CO-WD. We find that the observable properties of the explosions produced from such mergers resemble those of observed type Ia SNe, and in particular they can produce a wide range of peak-luminosities, consistent with those observed for normal type Ia SNe. Moreover, our population synthesis models show that, together with the contribution from mergers of massive double CO-WDs (producing the more luminous SNe), they can potentially reproduce the full range of type Ia SNe, their rate and delay-time distribution. Furthermore, mergers with low-mass CO WDs give rise to a wide variety of partial explosions that might reproduce the properties of subluminous types of type Ia SNe. We therefore suggest the mergers of hybrid WDs could play a key role in explaining the origins of of both normal and peculiar type Ia supernovae.

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