# Fundamentals of Explosions: Natural, Accidental, and Controlled

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**Course Description:** An *explosion* occurs when energy is released locally into a physical system faster than it can be smoothly equilibrated. The result is that the local pressure increases rapidly and shock waves form and propagate throughout the system. This general description covers scenarios including astrophysical events such as supernovae or solar magnetic eruptions, accidents such as vapor-cloud or coalmine explosions, and purposely created energetic processes in engines for high-speed propulsion. All of these events are based on similar principles of compressible flow, energy release into this flow, and the formation and propagation of shock waves.

This course introduces the physics and chemistry of explosions and investigates how explosions occur naturally (e.g., volcanoes and stars), accidentally (e.g., vapor cloud explosions, unsuccessful rocket launch, hydrogen accumulation from meltdowns), and by engineering design (e.g., detonation engines, air bags, shaped charges). We will cover the basics needed to understand these phenomena, and then take a forensics approach to understanding specific types of scenarios of interest to the class.

**Suggested Pre-requisites:** This course will be of most use to those who have some understanding of calculus, fluid dynamics (particularly compressible flows), some combustion science, heat transfer, and thermodynamics. A preliminary review of important elements of these topics will be given as needed. No textbook is available for this course (yet), although one is being prepared. References and reading materials will be provided to the students as the course proceeds.

**Expectations for Participants:** Participants will benefit the most if they are able to read the materials as provided before the lectures and actively participate in discussions.

**Upon completing this course, it is hoped that participants should understand:**

- the underlying physics of explosions
- how to apply this information to new situations
- how to analyze the behavior of an explosion, both *a posteriori* and *a priori*.
- how to relate explosions to other combustion or energy deposition phenomena
- the basics of shock physics and compressible flow dynamics
- how to compute the effects of confinement on compressible flows
- the physics of at least two different types of explosions