

16.512, Rocket Propulsion
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Lecture 1: Introduction

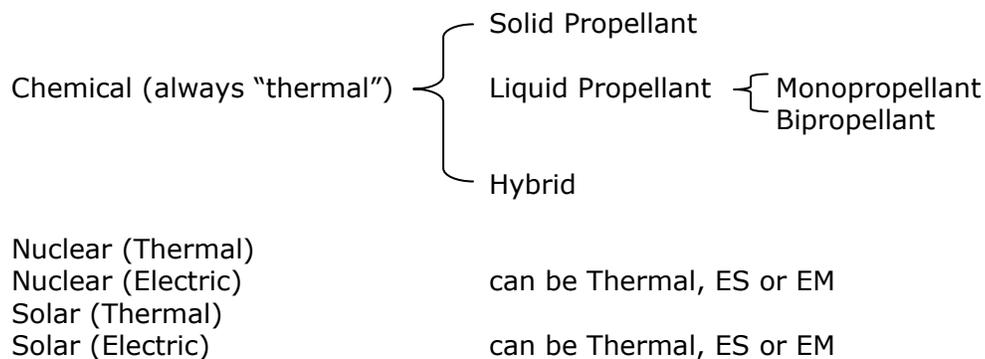
Types of Rockets (Engines)

- Depending on gas acceleration mechanism/force on vehicle mechanism.

"Thermal"	Gas pushes directly on walls by P (pressure) forces Nozzle accelerates gas by P forces (most large rockets, chem, nuclear, some electric...)
Electrostatic	Ions accelerated by \vec{E} field (a) Electrostatic force (push) on electrodes (Ion engines) (b) Force (push) on magnetic coils through gas \vec{j} (Hall thrusters)
Electromagnetic	Gas accelerated by $\vec{j} \times \vec{B}$ forces Force (push) on coils or conductors (MPD thrusters, PPT's)

16.512 concentrates on Thermal

- Depending on energy source:



16.512 deals mostly with Chemical.

- Depending on Thrust level (per unit mass)

- High thrust ($\geq 1g$) for launch, fast space maneuvering (16.512)
- Low thrust ($10^{-5} - 10^{-2} g$) for efficient in-space maneuvers (16.522)

1) <u>Non-Space missions</u> Atmospheric/Ionospheric Sounding Tactical Missile Medium-Long Range Missiles	<u>Rocket Type</u> Solid Propellant, 1-4 stages Solid Prop., 1-2 stages Solid or Liquid Prop., 2-3 stages (very high acceleration)
2) <u>Launch to space</u>	Solid, liquid or combinations, 2-4 stages (2-4g) Possible: hybrid, 2-4 stages
3) <u>Impulsive ΔV in space</u> (time-critical maneuvers, energy change from elliptic orbits, plane change from elliptic orbits, non-fuel-limited situations...) $\Delta V \leq 1000$ m/s	Small Solid Prop. (Apogee kick, etc) Bi-propellant (storable) liquids, Monopropellant (storable) liquids, Future: Nuclear thermal
4) <u>Low-Thrust ΔV in space</u> (Mass-limited missions $\Delta V \geq 2000$ m/s non time-critical missions, small, continuous orbit corrections near-circular orbits...)	Solar-electric systems: Arcjets (a bit faster, less Isp) Hall, Ion (slower, higher Isp) PPT (precision maneuvers) Nuclear-electric systems Direct solar-thermal