

# Space Weapons from a Technical Perspective

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- This presentation deals with definitions and types of space weapons from a technical perspective
- It is meant to give a basic understanding of the physics involved, the technical workings of space weapons, and their feasibility
- Comments and questions are welcome at any time during this presentation

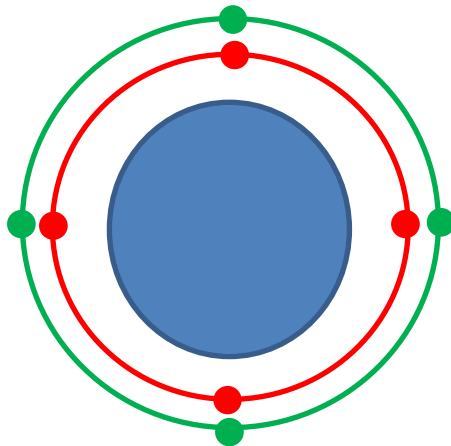
- The basic rules (physics review)
- General types of space weapons
  - Earth-based weapons that move through space to attack targets on the ground
  - Earth-based weapons that attack targets in space
  - Space-based weapons that attack targets in space, air, or on the ground
- The grey areas

# PHYSICS AND SPACE

- Velocity (speed) is not an independent variable
  - It is a function of altitude, and changing one changes the other
  - A school bus and an apple at the same circular orbit altitude will have the same speed (but one has a lot more *momentum*)
- Lack of air (friction) means *inertia dominates*
  - What goes in motion stays in motion for a very long time
  - Very difficult to change direction, cannot “maneuver” in space like in air
- At very high speeds, solid objects tend to behave like liquids when they collide
  - Think crossing two high pressure sprays from hoses
  - Resulting pieces end up in similar orbits as parents (with some changes)

- Standing on a satellite and throwing an object “down” will result in the object drifting away and coming back to your hand one orbit later
- A satellite does not orbit “around” another satellite
  - Both objects are in orbit around the Earth, but appear to move around each other

Motion relative to the Earth



Motion relative to each other

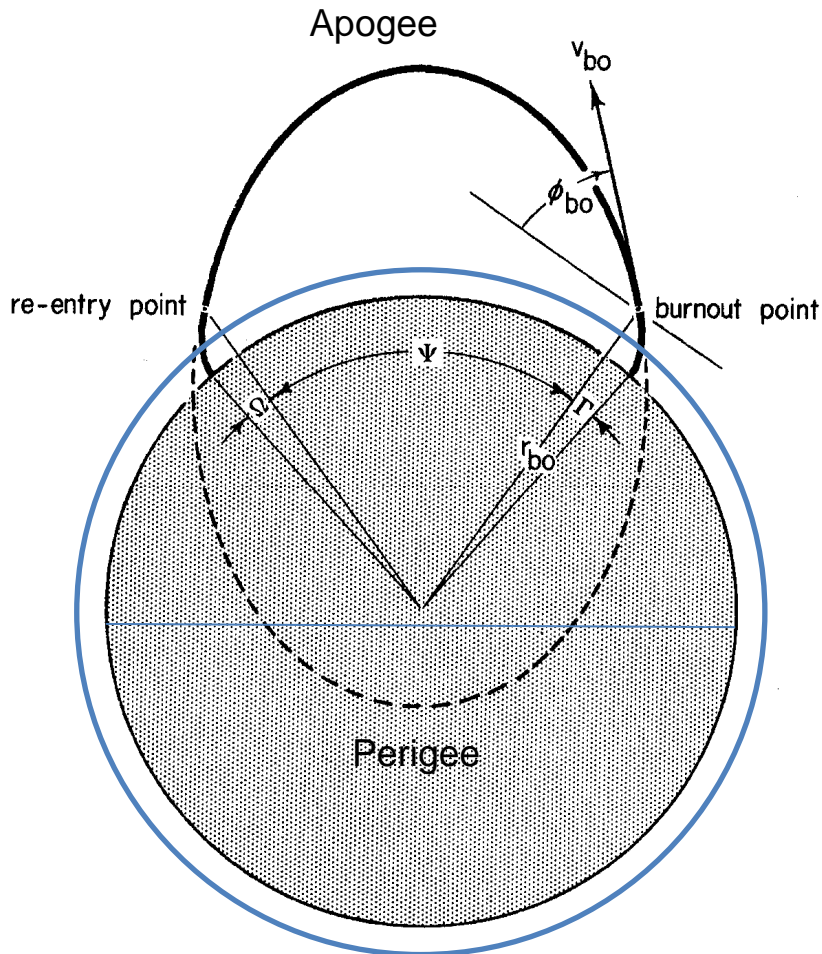


- Nuclear weapons do not behave in space as they do on the Earth
  - The lack of an atmosphere means a nuclear detonation will not produce a blast wave or blast effects
  - Less thermal energy is emitted and much more high frequency (X-ray and Gamma Ray)
  - Much greater release of prompt radiation
- Other significant effects
  - Electromagnetic pulse (EMP)
  - Short term interference with radar and radio communications
  - Long term damage through capture of charged particles by Earth's magnetic field, creating artificial radiation belts, and excitation of Van Allen belts

- Earth-based weapons that move through space to get to targets on the ground
  - Medium to long range ballistic missiles
- Earth-based weapons that attack targets in space
  - Direct ascent ASATs
  - Lasers and directed energy weapons
- Space-based weapons that attack targets in space, on the ground, or in the air
  - Co-orbital ASATs
  - Hypervelocity rods
  - Space-based lasers

# EARTH-BASED SPACE WEAPONS

- First ballistic missile was the German V-2 rocket during WWII
- Seized upon in the 1950's as a way of delivering nuclear weapons long distances in very short times (compared to bombers) and were difficult to intercept
- Most do not consider them to be true space weapons, but ballistic missiles can be the basis for other space weapons
- Usually classified by their range (greater than 5500 km range are considered Intercontinental Ballistic Missiles)



Sun-sync orbit (800 km)

- A ballistic trajectory is simply an orbit with a perigee inside the Earth
- Ballistic objects have higher apogees (point furthest away from Earth) than many satellites but do not have enough velocity to stay in orbit

- At a fundamental level, the only difference between a ballistic missile and a space launch vehicle is energy and payload
  - Ballistic missiles accelerate a payload to enough velocity to coast on an arc that re-enters the Earth's atmosphere
  - Space launch vehicles lift a payload to the desired altitude and accelerate it so it has enough velocity to remain in orbit
- Generally, any ballistic missile can be used as a launching platform for certain types of anti-satellite weapons
  - The altitude to which the missile can reach is roughly half its missile range
  - Needs to be mated with an interceptor which can perform the tracking and terminal guidance functions

- Ballistic missile launched from the ground, aircraft, or naval vessel with an interceptor (“kill vehicle”) on top
- After missile burnout, interceptor flies on a ballistic arc that intersects with the orbit of a satellite at a precise time
  - Interceptor must provide tracking of target, terminal guidance, and capability to maneuver for course corrections
- Usually no “warhead” is present on the interceptor, target is destroyed through kinetic energy alone
  - Some concepts have considered using nuclear warheads

- Generally work by increasing the surface heating of the target
  - Can cause rupture and collapse of weak structures under load (like missiles) if held on the target for some period of time (seconds)
  - Can blind and damage sensitive optics
- Travel to target “at speed of light” (dodging is virtually impossible), can only target “line of sight”
- Dazzling and blinding are proven, destroying or “blowing something up” via laser still not operationally feasible
  - Depends greatly on the material and construction of the target
  - Painting something white or reflective can degrade the capability of the laser severely

# SPACE-BASED SPACE WEAPONS

- An object that is already in orbit that conducts a series of maneuvers to intercept another satellite
  - Could also lay in wait for target satellite (“space mine”)
- Could rely on kinetic energy (collision) alone for destruction, but more likely to use other means
  - Release a cloud of metal pellets (“shotgun blast”)
  - Deliver an electromagnetic pulse
  - Explosive charge
  - Attach to target and fire thrusters

- Heavy metal rods released by an orbital platform that re-enter the atmosphere
- Rods have no explosive warheads, damage target through immense kinetic energy alone
- System has been discussed in theory but never developed, tested or deployed
  - Implementation poses significant technical challenges

- Satellites with lasers on-board that are used to destroy ground targets, other satellites, or nuclear warheads on ballistic arcs
- Requires extraordinary amount of power to generate
  - Some designs called for nuclear explosions to create X-ray lasers
  - Current research is attempting to develop chemical laser sources
- Systems have been theorized with some design work, but not built, tested, or deployed in space
  - Significant technical challenges still remain for operationally useful systems

- Any antenna can be turned into a jammer, which can then be used to negate or severely hinder a satellites' ability to broadcast or communicate
  - Difficult to entirely prevent or determine un-intentional interference, especially in the geostationary belt
- Many missile defense technologies have a dual-use as a potential space weapons
  - All kinetic hit-to-kill technologies are similar, and differ mainly in maneuverability and tracking capability

## “The Physics of Space Security”

by the Union of Concerned Scientists  
(available for free on the Web)

## The Physics of Space Security

A Reference Manual

*David Wright, Laura Grego, and Lisbeth Gronlund*

AMERICAN ACADEMY  
OF ARTS & SCIENCES  
RECONSIDERING THE RULES  
OF SPACE PROJECT



# Thank you for your time. Questions?

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