

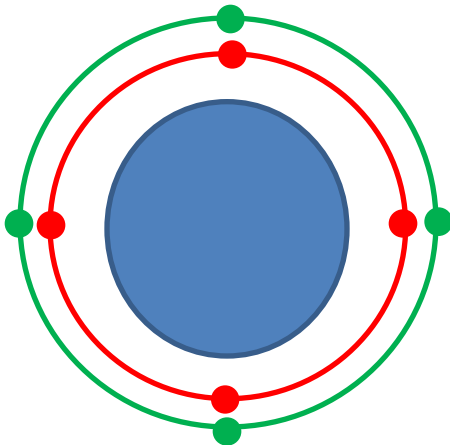
# The Physics of Space Weapons

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- 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
- 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

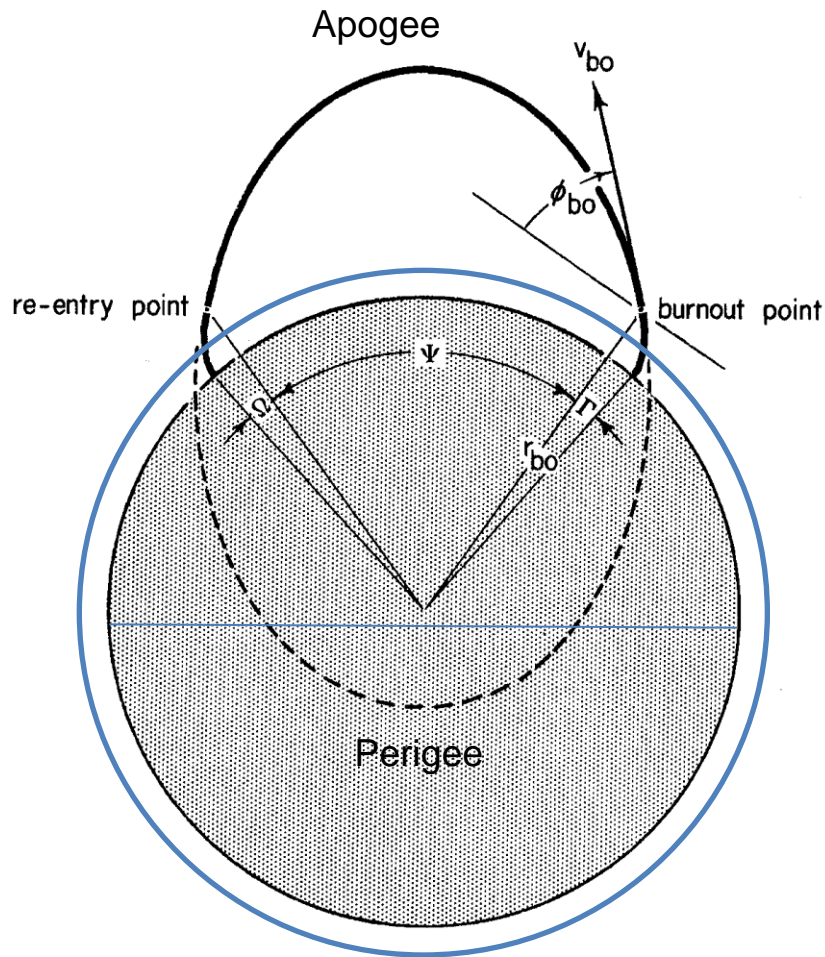


Motion relative to each other



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

- 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)
- Most do not consider them to be true space weapons, but the principles of ballistic missiles are used in other space weapons
- Usually classified by their range
  - SRBM
  - IRBM
  - MRBM
  - ICBM



Sun-sync orbit (800 km)

- A ballistic trajectory is simply an orbit with a perigee inside the Earth
- Ballistic objects have apogees much higher than most space launches but do not have enough velocity to stay in orbit

# Intercontinental ballistic missiles(ICBMs)

*Promoting Cooperative Solutions for Space Security*



- Ballistic missile launched from the ground (or airplane) with an interceptor on top
- Interceptor flies on a ballistic arc that intersects with the orbit of a satellite at a precise time
- No explosives on the interceptor, target is destroyed through kinetic energy (mass times velocity) alone
- No real difference between the core kinetic kill technology used to intercept ballistic missiles and satellites
- Developed by the US, Soviet Union, and China (only Chinese program still active)







- Lasers and particle beams
- Generally work by increasing the surface heating of the target
  - Can cause rupture and collapse of weak structures under load (like missiles)
  - 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 capabilities
- Destroying or “blowing something up” in space via laser still very much sci-fi

- A satellite that is in orbit and maneuvers to intercept another satellite
- 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 and fire thrusters
- A co-orbital ASAT system was developed and tested by the Soviets in the 1960’s and 1970’s but stopped in the 1980’s, assumed canceled

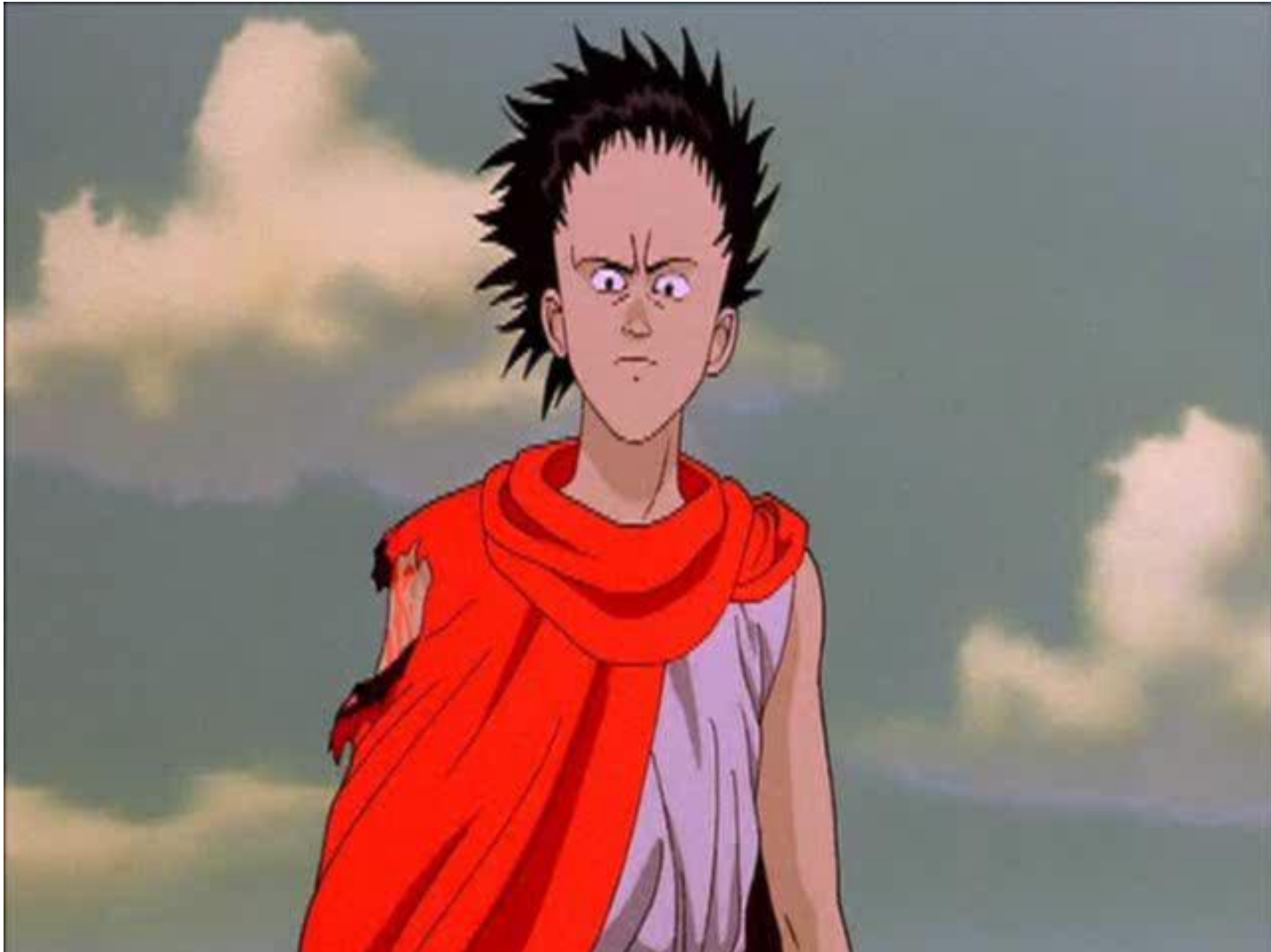
- Heavy metal rods released by an orbital satellite that re-enter the atmosphere
- Rods have no explosive warheads, damage target through immense kinetic energy alone
- System has been discussed in theory but never developed, tested or deployed





- 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, 1980's designs called for nuclear explosions to create X-ray lasers
- Systems have been designed but not deployed





## “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





# Questions?

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