



# HESTEMP

## Orbital Maneuvers for Small Satellites

*Low Thrust (vs) High Thrust*

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# Historical Background

- Authors Bate, Mueller and White suggested in their book *Fundamentals Of Astrodynamics* that Isaac Newton mentioned orbital maneuvers and satellites in his famous *Principia 1687*.
- Actual satellite maneuvering didn't actually happen until after sputnik on *Oct 4, 1957*.
- Jan 2, 1959 the Soviets launched Luna 1 requiring many maneuvers such as circularizing the the initial orbit



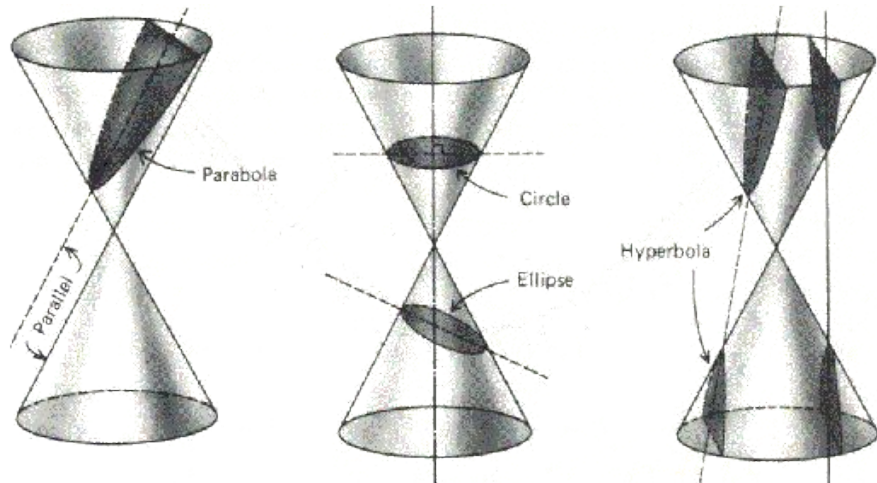
# Materials Covered

1. Introduction to NASA  
Ames and Small Satellite  
Technology Development
2. Coordinate Systems and  
Transformation
3. Equations of Motion
4. Orbital Maneuvering
5. Attitude Control

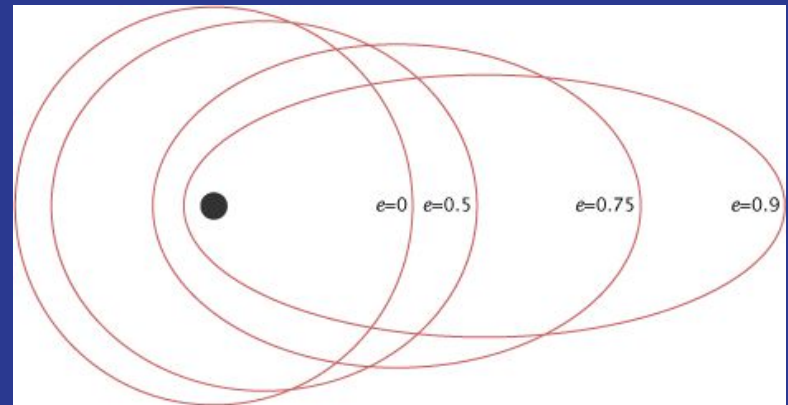


# Orbital Maneuvering

## *Maneuvers*



- The weight of Small Satellites is critical when considering any maneuvers therefore efficiency is essential.
- Efficiency can mean using the minimum amount of fuel to accomplish given task



# Thrust Transfers

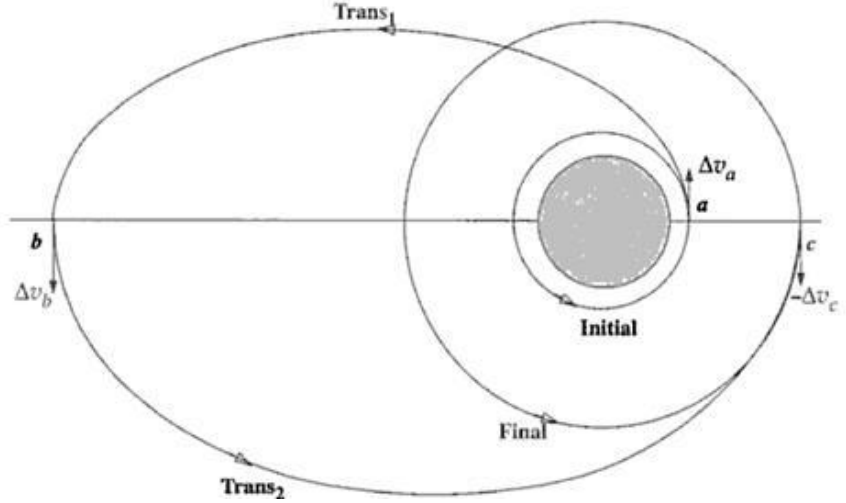
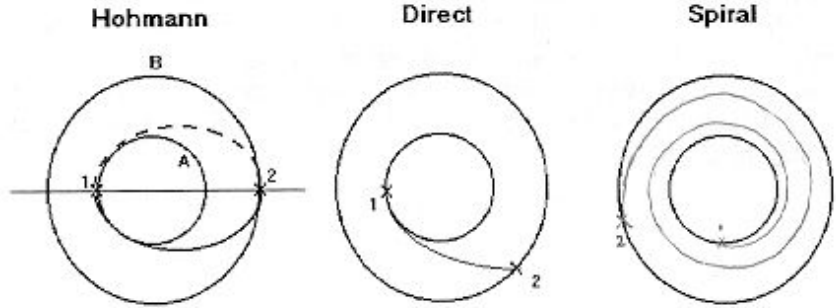
## Low Thrust Transfer

- High Isp  $\longrightarrow$  Low Thrust
- Alfano Transfer



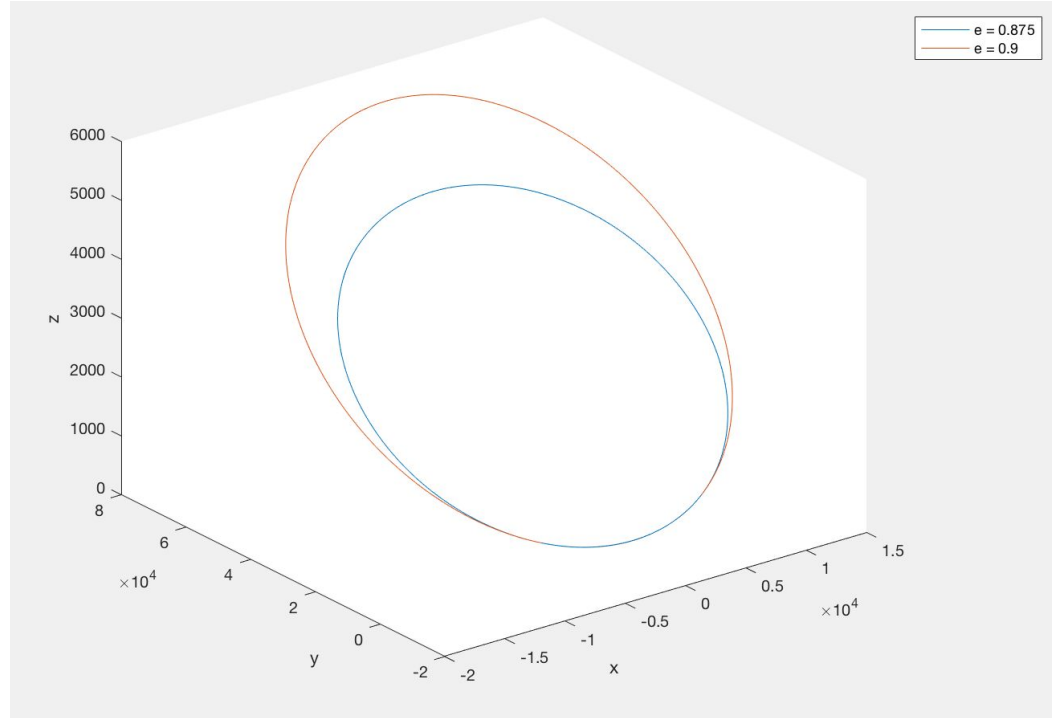
## High Thrust Transfer

- Low Isp  $\longrightarrow$  High Thrust
- Bi Elliptic Transfer



# Simulation of Orbit

- MatLab Simulated Orbit
- Blue:  $e = 0.875$
- Red:  $e = 0.9$



# Future Research

- *Code for simulations*
- *Conclusion of Low Thrust vs High Thrust from experiment*

## References

- Vallado, D. A., & McClain, W. D. (2001). *Fundamentals of astrodynamics and applications*. Dordrecht: Kluwer Academic.
- Bate, R., Mueller, D. D., & White, J. E. (1971). *Fundamentals of astrodynamics*. New York: Dover Publications.
- [https://www.nasa.gov/mission\\_pages/smallsats](https://www.nasa.gov/mission_pages/smallsats)
- Edelbaum, T., Sackett, L., & Malchow, H. (1973). Optimal low thrust geocentric transfer. *10th Electric Propulsion Conference*. doi:10.2514/6.1973-1074