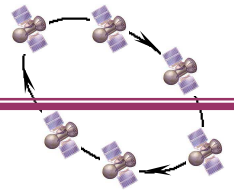
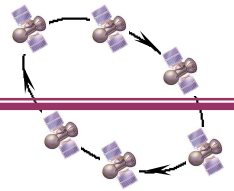


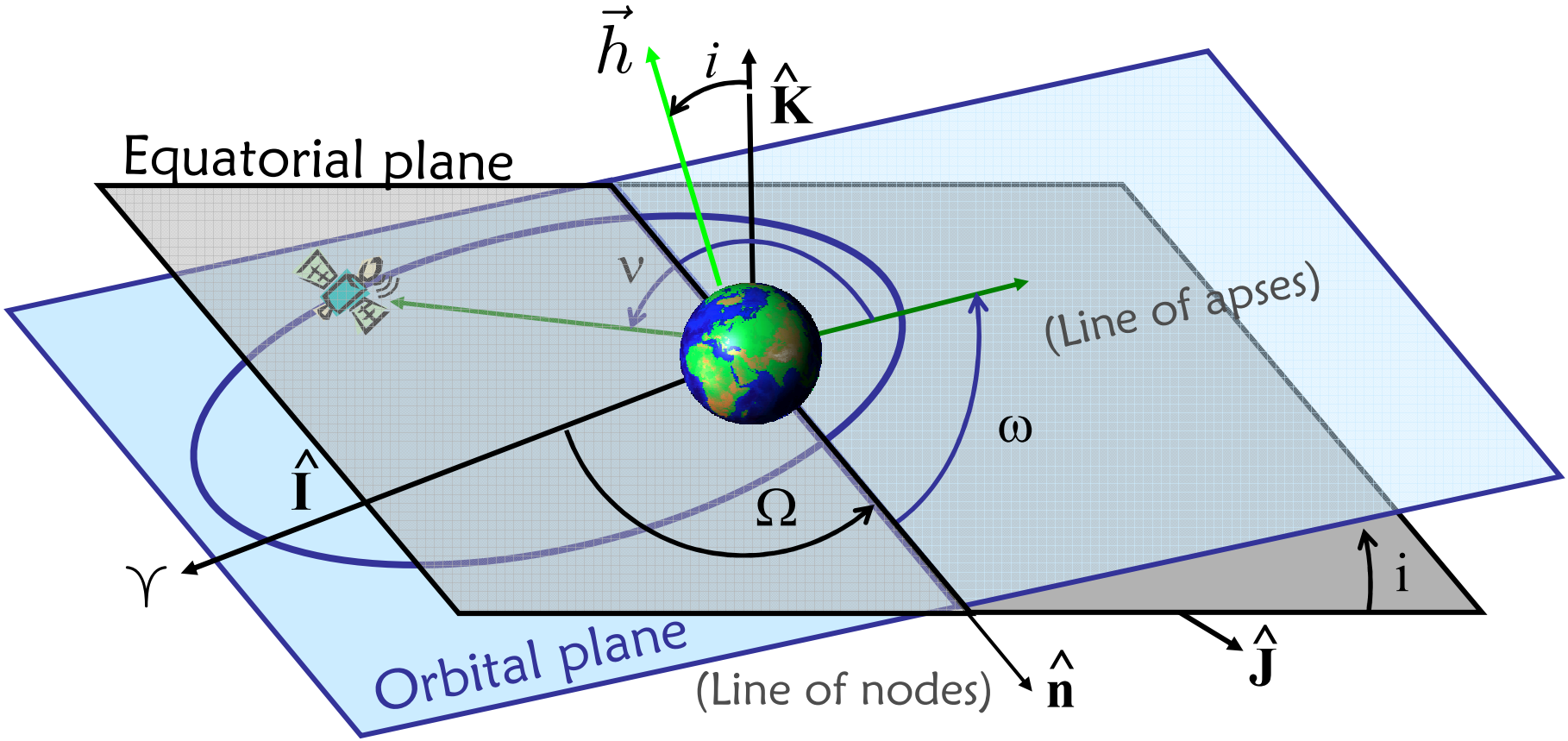
Two-Line Element Sets

- Orbital elements are a set of 6 numbers that describe an orbit
- A standard way to communicate orbital elements for real Earth-orbiting satellites is through the "two-line element set", or TLE *
- TLEs include not only the orbital elements, but also other information about the satellite, including information about the effects of perturbations such as aerodynamic drag

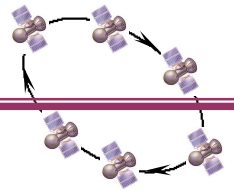
Note that "TLE" is a Three-Letter Acronym, or TLA



The Classical Orbital Elements



- semimajor axis (size of orbit), a;
- eccentricity (shape of orbit), e;
- inclination, i;
- Longitude of ascending node, Ω ;
- argument of periapsis, ω ;
- true anomaly, ν ;



The Two-Line Element (TLE) Sets for Orbital Elements

The TLE is a standard format for communicating of orbital elements of an earth-orbiting satellite.

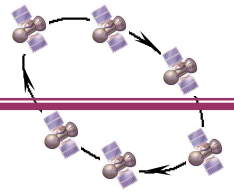
The first row of numbers shown here are the orbital elements.

Note that the "mean motion" n is directly related to the semi-major axis a, and the "mean anomaly" M is directly related to the true anomaly ν

In the unperturbed two-body problem, n is constant, but in reality it varies slightly and the TLE reports that variation, along with the "ballistic coefficient"

$$\bar{n} = \sqrt{\frac{\mu}{a^3}} \quad e \quad i \quad \Omega \quad \omega \quad M$$

$$\frac{\dot{n}}{2} \qquad \frac{\ddot{n}}{6} \qquad B^* = \frac{C_D A}{2m}\rho_0 \quad UTC$$



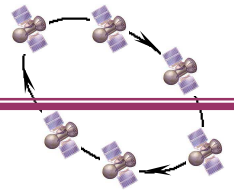
The Two-Line Element (TLE) Sets for Orbital Elements

Example:

	Satellite Number	International Designator	Epoch	$\frac{\dot{n}}{2}$	$\frac{\ddot{n}}{6}$	BStar	Element Number
			YYDDD•DDDDDDDD	S•	S	S SE	
1	16609U	86017A	93352.53502934	.00007889	00000 0	10529-3	34

		Inclination	Right Ascension of node	Eccentricity	Argument of perigee	Mean Anomaly	Mean Motion	Epoch Rev
2	16609	51.6190	13.3340	0005770	102.5680	257.5950	15.59114070	44786

Note: See http://celestrak.com/ for everything you need to know about TLEs



Matlab Code for Reading TLEs

```
function [elements,epoch,yr,M,E,satname] = TLE2oe(fname);
% fname is a filename string for a file containing
%          a two-line element set (TLE)
% elements is a 1/6 matrix containing the orbital elements
%          [a e Om inc om nu]
% yr is the two-digit year
% M  is the mean anomaly at epoch
% E  is the eccentric anomaly at epoch
% satname is the satellite name

% Calls Newton iteration function file EofMe.m

function E = EofMe(M,e,tol)
% this function solves Kepler's equation,
% computing E as a function of M and e
```

These functions are available directly from me