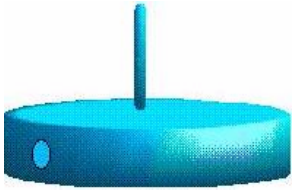
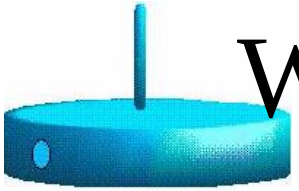


Nanosat Magnetometry

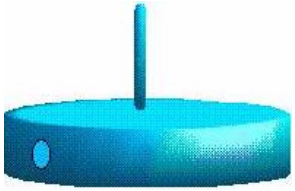
Robert Sheldon

University of Alabama in Huntsville



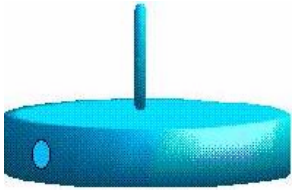
Why Nanosat Magnetometers?

- Magnetic fields must be measured *in situ*
  - (We too wish we could do it with imaging!)
- Magnetic fields must be measured *globally*
  - Fields are a global, not local, effect
- Magnetic fields must be measured *simultaneously*
  - Otherwise space/time ambiguities destroy the image
  - Siscoe http://cspar181.uah.edu/RbS/wpaper.html
- Magnetic fields must be measured *densely*
  - Currents and structure are “narrow” boundary features
- The economics of 100’s of satellites => nanosats



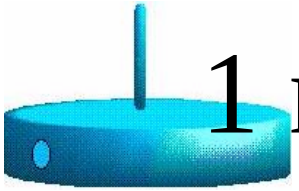
Magnetometer Choices

- Fluxgate Mag
  - miniaturized, accurate, inexpensive, flight proven
  - drifting baseline
- Absolute Mags: He vector, proton precession
  - too heavy, too big, and too power hungry
- Search coil Mag
  - less accurate, 2-axis only
- Microfabricated Mag
  - Xylophone key, Giant resonance, Force
  - wide dynamic range, but not flight-proven



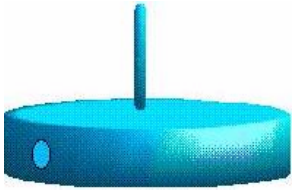
Sensitivity and Accuracy

- Need better than 1nT sensitivity at L>6 Re
  - This = 1/500 = 0.2% accuracy in magnitude
  - And = 1/2 degree accuracy in pointing
- Science goals:
  - Alfven waves, current systems, global models
- Nice to have 1nT at L<6 Re as well
  - Requires 1/30,000 = .003% accuracy in magnitude!
  - Requires 1/2 arc-minute accuracy in pointing!
- Can nanosats get close to these requirements?

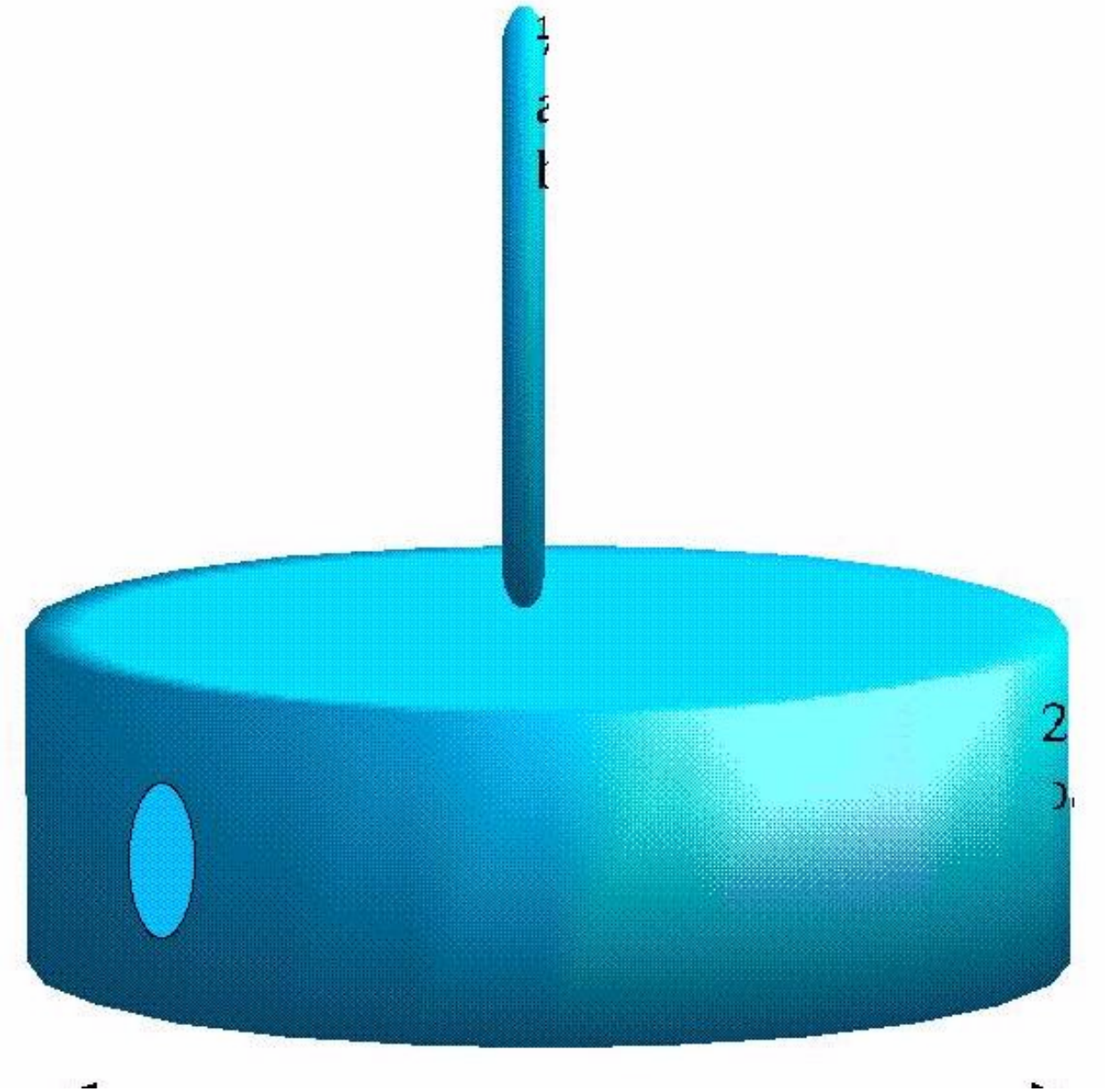


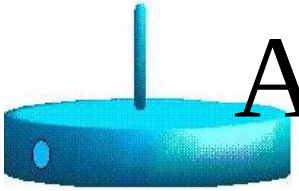
1 nT & Background Contamination

- Three sources of background:
  - Pointing error, induced currents, internal currents
- Traditional methods of reducing background
  - 3-axis or “slow” spinners use booms + cleanliness
  - Baseline drift is removed by mechanical “flippers”
- Non-traditional methods of “fast” spinners
  - Analogous to Gaussian spherical harmonic methods
  - Oversampling with Fourier decomposition
  - Spacecraft current monitors
- Can nanosats employ these techniques?



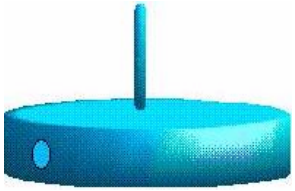
The “Tuna Can” Nanosat



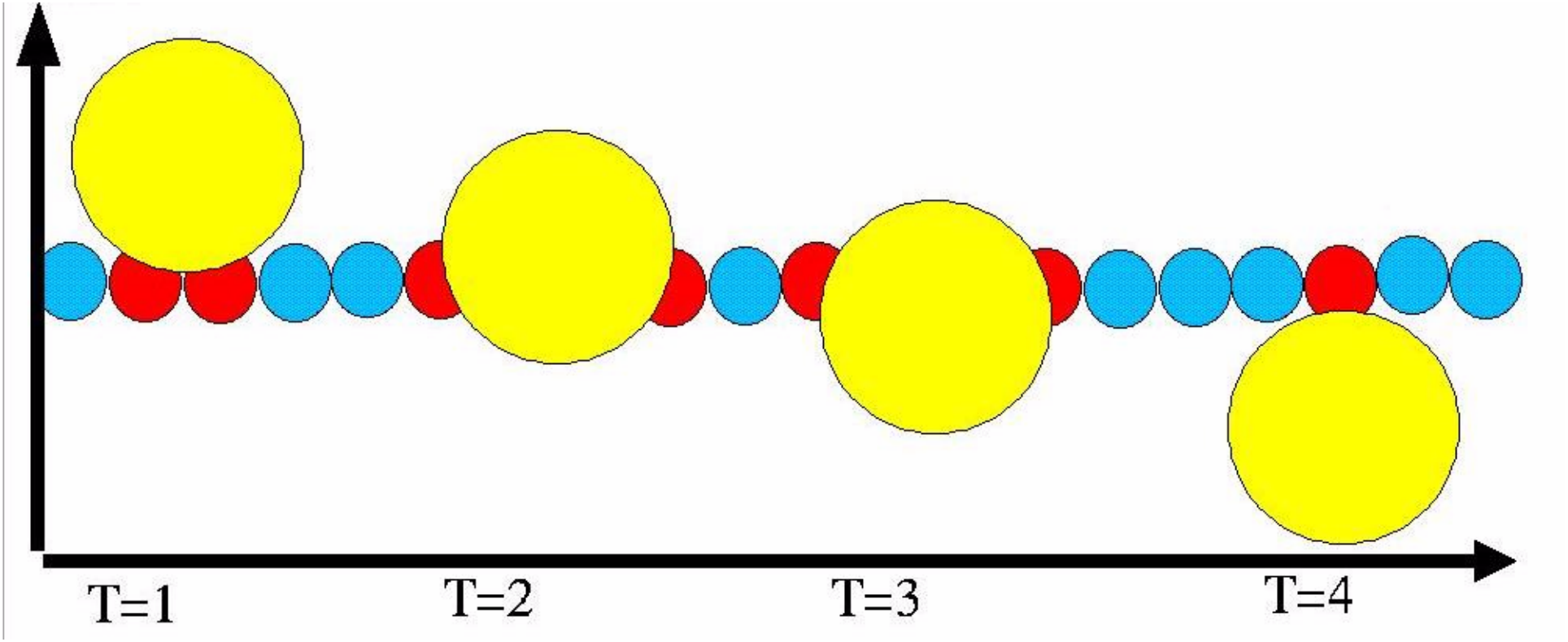


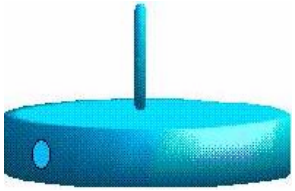
Arc-Minute Pointing Accuracy

- No need to *control* pointing, only *measure* it.
- A fast spinner has stable spin vector; we need only measure it occasionally.
- A fast spinner needs only a 1-D photodiode array to determine 2-D location of sun-vector.
  - 100mm focal length optics, 256 pixels, ~10 grams, 2bits, 8channel ADC, 1kHz samples for 60rpm.
- Spin & nutation model with secular terms is updated in memory once per orbit (after perigee), attitude then comes from the model.

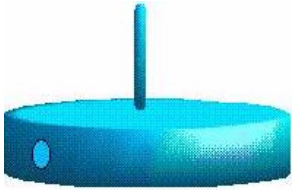


Sun Sensor Schematic

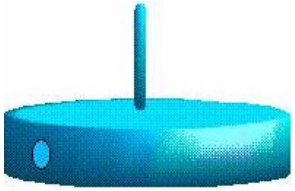




Fourier Oversampling



3-Axis Spinners



Nanosat Conclusions