The Future of Time

http://svs.gsfc.nasa.gov/vis/a000000/a004100/a004118/index.html

The Future of Time

Timekeeping and Astronomy

Why are we here?

- A proposal is being vigorously pursued within the (*Radiocommunication Sector of the*) International Telecommunication Union (*an agency of the United Nations*) that would redefine Coordinated Universal Time to no longer be tied to the rotation of the Earth

What resources are available?

- Decoupling Civil Timekeeping from Earth Rotation
  - *http://futureofutc.org/2011/preprints/*
- Requirements for UTC & Civil Timekeeping on Earth
  - *http://futureofutc.org/preprints/*
- Both proceedings published by the AAS (American *Astronautical* Society)
  - *http://www.univelt.com/Science.html*
- Steve Allen's web resources
  - *http://www.ucolick.org/~sla/leapsecs/*

The Machinery of Time

…but perhaps it was fated

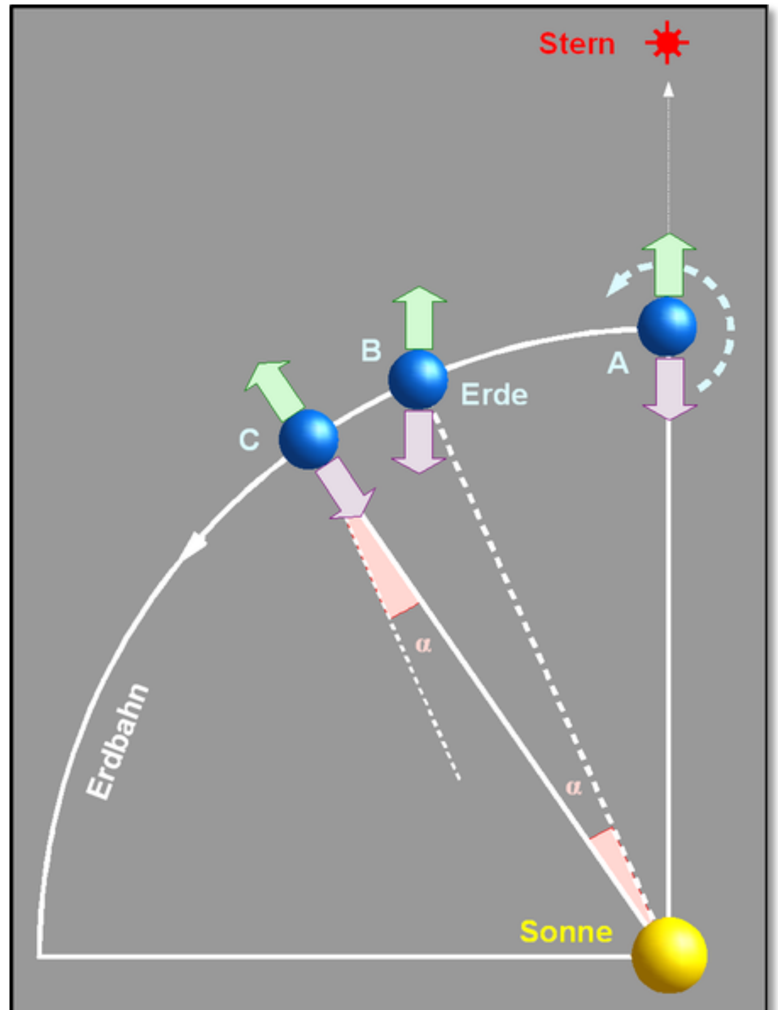
What is Universal Time?

- "The terms Greenwich Civil Time (G.C.T.), Weltzeit (W.Z.) and Universal Time (U.T.) indicate time computed from Greenwich mean midnight without ambiguity."
  http://iau.org/static/resolutions/IAU1928_French.pdf

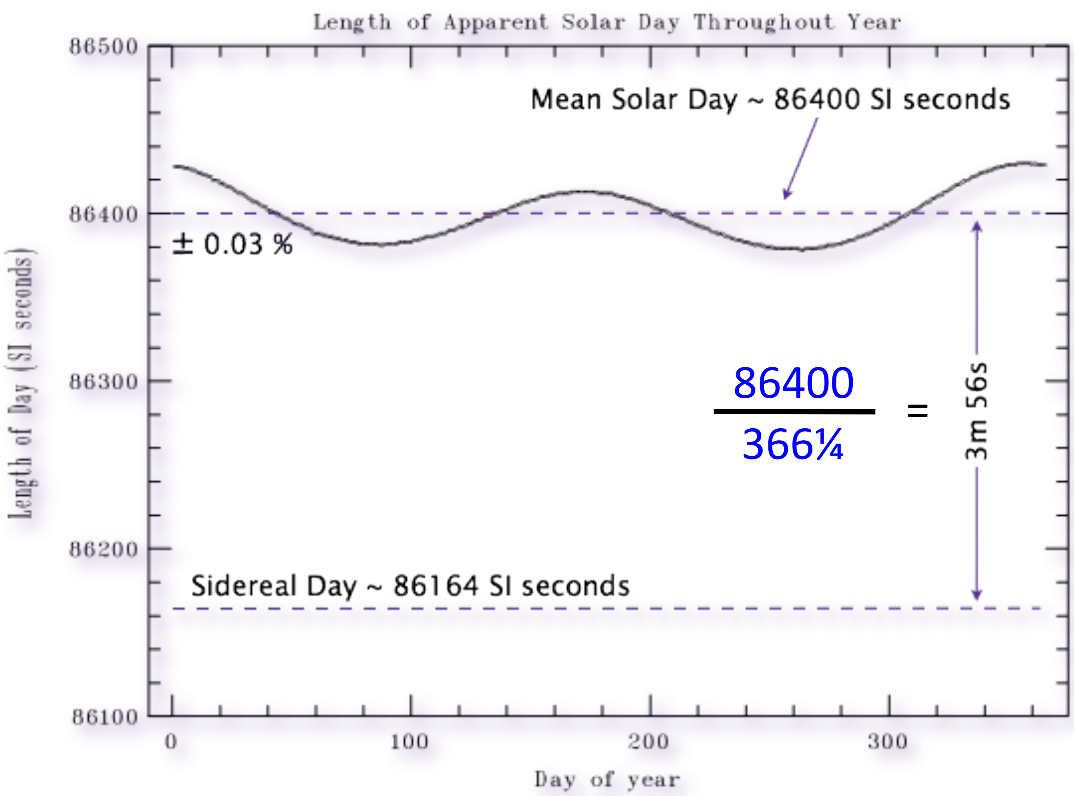
- "GMT may be regarded as the general equivalent of UT." - *ITU-R (CCIR) TF.460-4*

UT results from the Synodic Day

- The synodic day is the time to rotate relative to the Sun *(A-C)*
- As opposed to the sidereal rotation period, relative to the stars *(A-B)*
- The number of days in a year is one fewer than the number of rotations *(Earth laps the Sun)*



How long is a Day?



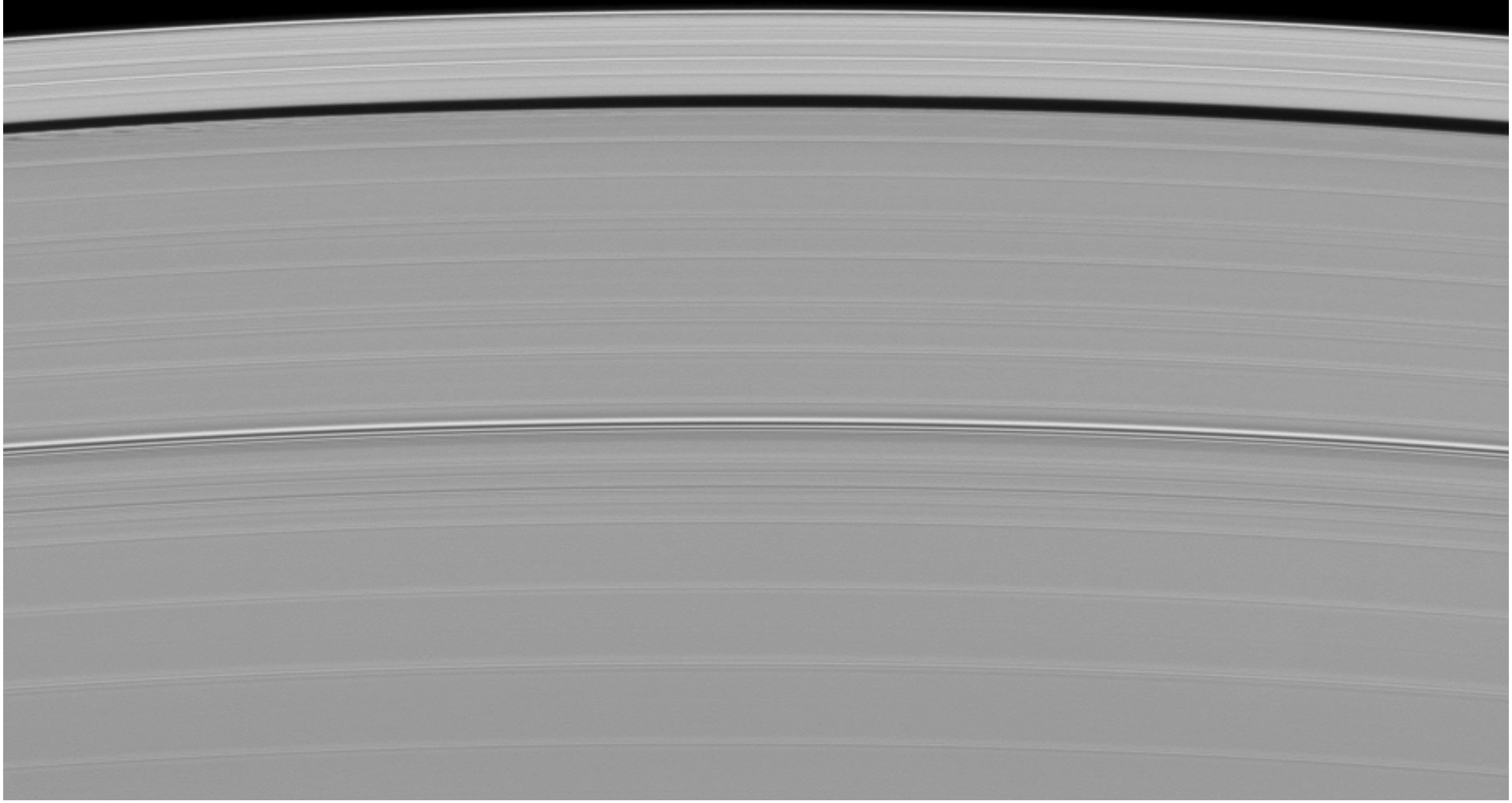
Derivative of the equation of time

- Sidereal rotation period is constant *(albeit slowly varying)*
- Each apparent solar day differs slightly
- Daily residuals accumulate as Equation of Time
- Daily ms level epsilon from 1820 epoch *(invisible at this scale)*
- ε's accumulate as Leap Seconds

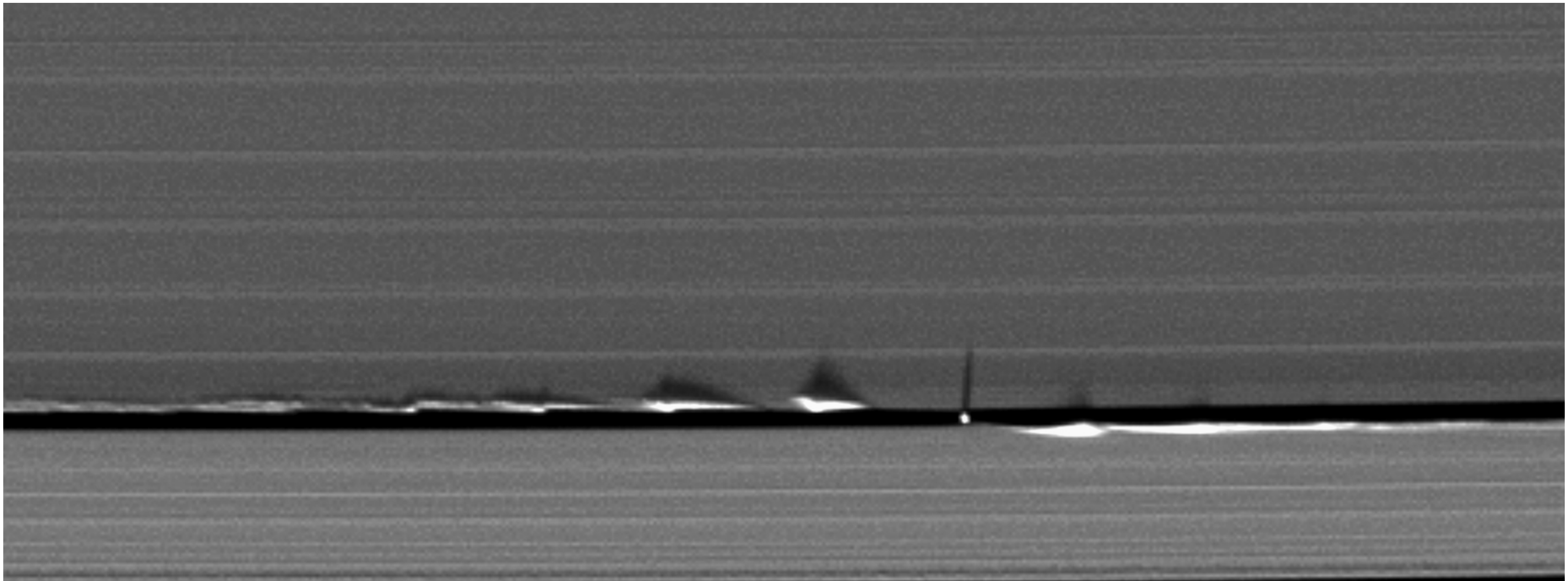
Not just the Earth: moons of Saturn

Object	Year *(Earth-days)*	Rotational Period *(d)*	Rotations per Year	Days per Year	Day *(Earth-days)*	Delta *(seconds)*
Daphnis	10759.22	0.59408	18110.73	18109.73	0.59411	3
Mimas	“	0.94242	11416.59	11415.59	0.94250	7
Enceladus	“	1.37022	7852.18	7851.18	1.37039	15
Tethys	“	1.88780	5699.34	5698.34	1.88813	29
Dione	“	2.73692	3931.14	3930.14	2.73762	60
Rhea	“	4.51821	2381.30	2380.30	4.52011	164
Titan	“	15.945	674.77	673.77	15.969	2071
Iapetus	“	79.322	135.64	134.64	79.911	50890

Not just moons and planets



Daphnis and the Keeler gap



To surf these waves, we'd need a solar chronometer

Session 1 – Historical context

- A (brief) history of time in astronomy
  Ken Seidelmann, UVA

- Time scales and concepts
  Arnold Rots, SAO

- Time and Navigation: The Untold Story of Getting From Here to There
  Andrew Johnston, NASM

- Time and the Earth: Long term trends
  Ken S. for F. R. Stephenson, Durham University

Short break around 3 pm

Session 2 – Astronomical impacts

- Terminology requirements for UTC
  Kara Warburton, Chair ISO TC 37 (Terminology)
- Performing your UTC software inventory
  Rob Seaman, NOAO
- Network time and infrastructure
  Harlan Stenn, Network Time Foundation
- Discussion: Operational implications for observatories
  Alison Peck, ALMA & Chair SPIE Observatory Operations