IAU WG on NSFA

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Brief History

- First Sub-group on Numerical Standards of the IAU WG on Astronomical Standards
  - Headed by M. Standish
  - Established many of the rules
    - Two-tiered approach to constants
  - Created the first list of Current Best Estimates (CBEs)
- IAU WG on Astronomical Standards
  - Chaired by T. Fukushima
  - Much of the work concentrated on constants in a general relativistic framework and the changes in the nutation models
  - Created a revised list of CBEs

Summary of Changes since the last CBEs

- Adoption of new precession
  - IAU 2006 Resolution B1
    - Precession of the equator
    - Precession of the ecliptic
- Redefinition of TDB
  - IAU 2006 Resolution B3

WG Numerical Standards of Fundamental Astronomy

- Goals
  - Update "IAU Current Best Estimates"
  - Conformal with IAU Resolutions/IERS Conventions/SI
- Members

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Which constants should be considered by WG?

- Initially started with the previous list produced by Fukushima (2003)
- Additional constants as suggested by WG members

What values should be adopted as the IAU CBEs?

- Initially started with the previous list produced by Fukushima (2003)
- Numerical values as suggested by WG members
- What level of accuracy is required?
  - Best possible accuracy

Current Best Estimates (SI)

- Natural Defining Constants
  - c
- Natural Measurable Constants
  - G
- Auxiliary Defining Constants
  - K
  - L_G
  - L_B

Current Best Estimates (SI)

Body Constants

- M_M/M_E
- M_S/M_{Me}
- M_S/M_V
- M_S/M_{ma}
- M_S/M_J
- M_S/M_{Sa}
- M_S/M_U
- M_S/M_N
- M_S/M_P
- M_S/M_{Eris}
- M_{Ceres}/M_S
- M_{Pallas}/M_S
- M_{Vesta}/M_S
- a_e
- J_2
- GM_E
- W_0
- ω
- ψ_{J2000}

Current Best Estimates (SI)

- Initial Values
  - ε_0
  - τ_A
- Others?
  - L_C
  - TDB_0

What mechanism should be adopted to keep the CBEs current?

- Options
  - When appropriate, IAU forms WG to update the CBEs
  - Enlist the aid of the IERS Conventions
    - Mechanism already in place
    - Serves slightly different users — Is this a problem?
  - Provide lesser accuracy to ensure longer "shelf life"
    - Requires users with the highest accuracy requirements to have access and know where to look for high accuracy estimates

Link between Theory and Constants

- Meaning of constants is ambiguous (at best) without carefully defined theoretical context
- What are the implications for the WG?
  - Concerns about consistency
  - Concerns about documentation
- What are the solutions?
  - How to provide unambiguous documentation?

What is the role of electronic information in CBEs?

- Used as primary source of information
  - Provide web page of constants and documentation on models?
  - Provide links to pages of constants and documentation on models?
- Used as supplemental information
  - Provide links to additional pages

Additional Concerns

- System of units
  - SI only
  - Mostly SI with few exceptions
  - Also include TDB units?

Should the IAU System of Constants be updated?

- Most members believe it is time to update the IAU constants

Coordination

- Working in close cooperation with
  - IAU Commission 52
  - IERS
  - BIPM Consultative Committee for Units (CCU)

Backup Slides

Current Best Estimates (SI)

Constant	Value	Reference	Adopted
Natural Defining Constants			
c	$2.997\ 924\ 58 \times 10^{8}$ $[ms^{-1}]$	CODATA 2006	IERS
Natural Measurable Constants			
G	$6.674\ 28(67) \times 10^{-11}$ $[m^3kg^{-1}s^{-2}]$	CODATA 2006	
Auxiliary Defining Constants			
k	$1.720\ 209\ 895 \times 10^{-2}$	IAU 1976	IAU
L_G	$6.969\ 290\ 134 \times 10^{-10}$	IAU Resolution /Petit 2000	IAU, IERS
L_B	$1.550\ 519\ 768 \times 10^{-8}$	IAU Resolution	IAU, IERS

Current Best Estimates (SI)

Constant	Value	Reference	Adopted
Body Constants			
M_M/M_E	$1.230\ 003\ 71(4) \times 10^{-2}$	Standish 2007	
M_S/M_{Me}	$6.023\ 6(3) \times 10^{6}$	Anderson et al. (1987)	
M_S/M_V	$4.085\ 237\ 19(8) \times 10^{5}$	Konopliv et al. (1999)	
M_S/M_{Ma}	$3.098\ 703\ 59(2) \times 10^{6}$	Konopliv et al. (2006)	
M_S/M_J	$1.047\ 348\ 625(17) \times 10^{3}$	Jacobson (2003)	
M_S/M_{Sa}	$3.497\ 901\ 8(1) \times 10^{3}$	Jacobson et al. (2006)	

Current Best Estimates (SI)

Constant	Value	Reference	Adopted
Body Constants			
M_M/M_U	$2.290\,298(3) \times 10^4$	Jacobson et al. (1992)	IERS
M_S/M_N	$1.941\,224(4) \times 10^4$	Jacobson et al. (1991)	IERS
M_S/M_P	$1.365\,78(39) \times 10^8$	Tholen et al. (2007)	
M_S/M_{Eris}	$1.191(14) \times 10^8$	Brown and Schaller (2007)	
M_{Ceres}/M_S	$4.72(3) \times 10^{-10}$	Pitjeva and Standish (2007)	
M_{Pallas}/M_S	$1.03(2) \times 10^{-10}$	Pitjeva and Standish (2007)	
M_{Vesta}/M_S	$1.35(2) \times 10^{-10}$	Pitjeva and Standish (2007)	

Current Best Estimates (SI)

Constant	Value	Reference	Adopted
Body Constants			
a_e	6.378 136 6(1) x 10^6 [m]	Groten (2000)	IERS
J_2	1.082 635 9(1) x 10^{-3}	Groten (2000)	IERS
GM_E	3.986 004 418(8) x 10^{14} [m^3s^{-2}]	Groten (2000)	IERS
W_0	6.263 685 60(5) x 10^8 [m^2s^{-2}]	Groten (2000)	IERS
ω	7.292 115(variable) x 10^{-11} [rad s^{-1}]	Groten (2000)	IERS
Ψ_{J2000}	5.038 481 507 x 10^3 [‘’/cy]	Hilton et al. (2006)	IAU

Current Best Estimates (SI)

Constant	Value	Reference	Adopted
Initial Values at J2000.0			
ε_0	8.438 140 6 x 10^4 [“]	Hilton et al. (2006)	IAU
τ_A	4.990 047 838 26 (10) x 10^2 [s]	Pitjeva and Standish (2007)	
Others			
L_C	1.480 826 867 4(14) x 10^{-8}	Irwin and Fukushima (1999)	IAU, IERS
TDB_0	-6.55 x 10^{-5}		