Solar Coordinates

James R. Graham

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Solar Coordinates

- Describe solar position in terms of latitude and longitude

- The position of a point projected onto the plane of the sky can be computed using coordinate transformations

- Solar ephemeris at:

  `http://ssd.jpl.nasa.gov/horizons.cgi`

  Gives heliocentric latitude (`Obs sub-lng & sub-lat`) and PA of spin axis (`N. Pole Pos. Ang & Dis`)

Solar Coordinates

$$x = R_o \sin\theta \cos\phi$$
$$y = R_o \sin\theta \sin\phi$$
$$z = R_o \cos\theta$$

$R_\odot$

z

θ

y

x

ϕ
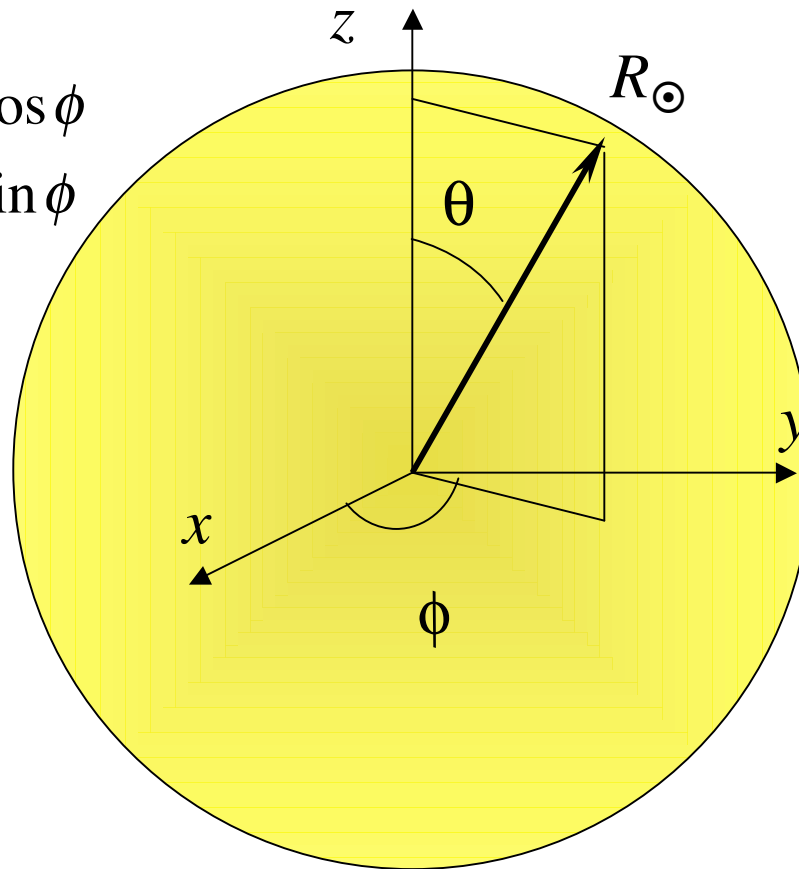
$$\dot{x} = -R_o \sin\theta \sin\phi \, \dot{\phi}$$
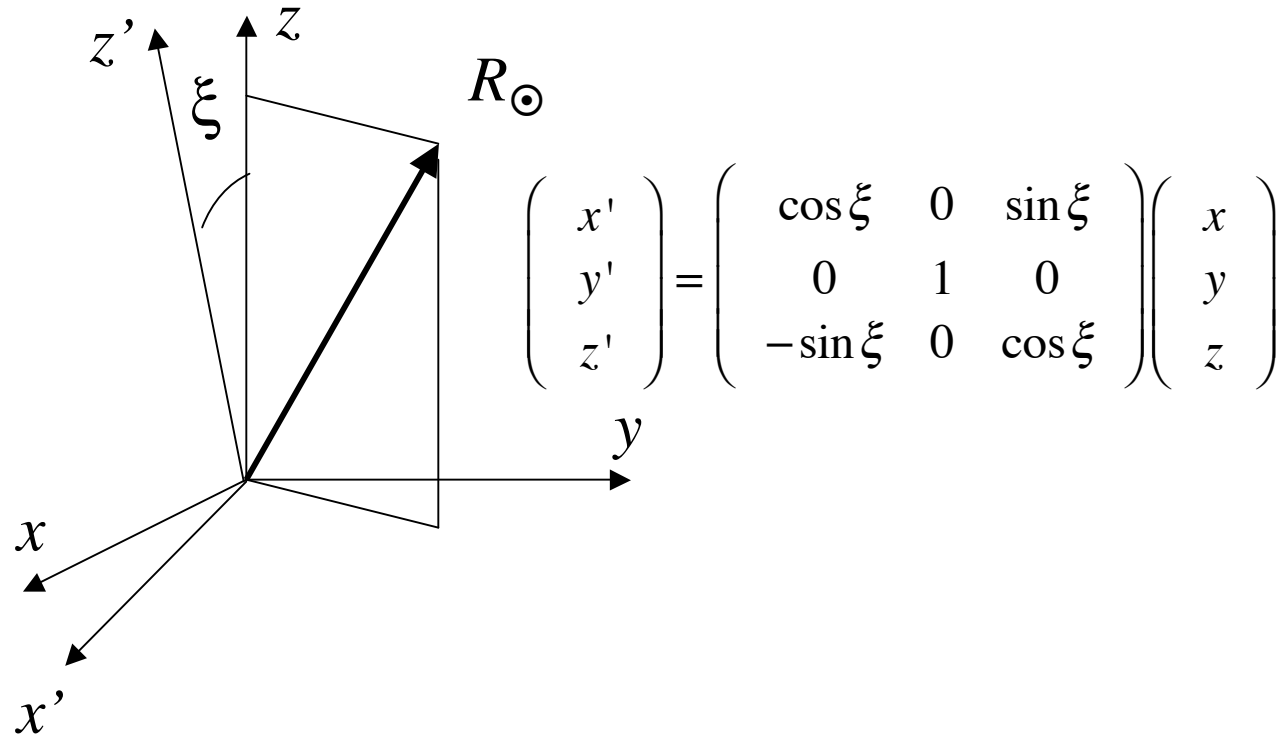$$\dot{y} = R_o \sin\theta \cos\phi \, \dot{\phi}$$
$$\dot{z} = 0$$
$$\dot{\phi} = 2\pi / T$$

T = rotation period

The z-axis is the solar spin axis

Coordinate Transformation #1

The solar spin axis is not perpendicular to the ecliptic—the center of the sun as viewed from earth is not $b=0$

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\xi & 0 & \sin\xi \\ 0 & 1 & 0 \\ -\sin\xi & 0 & \cos\xi \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

Rotate about the y-axis by the angle ξ
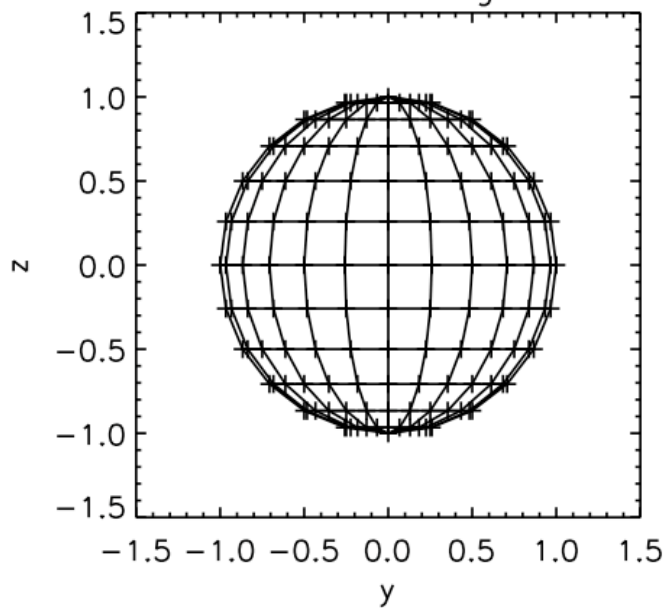Tilt of the solar spin axis towards the earth

Coordinate Transformation #2

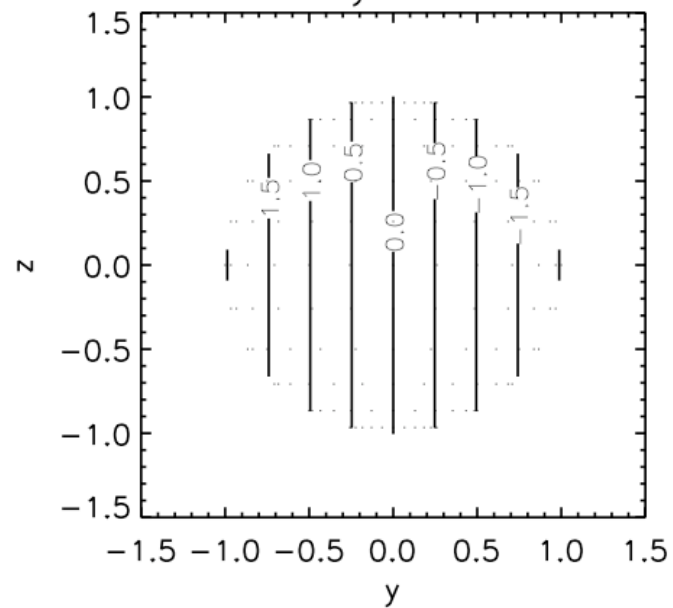The projected solar spin axis is not oriented N/S
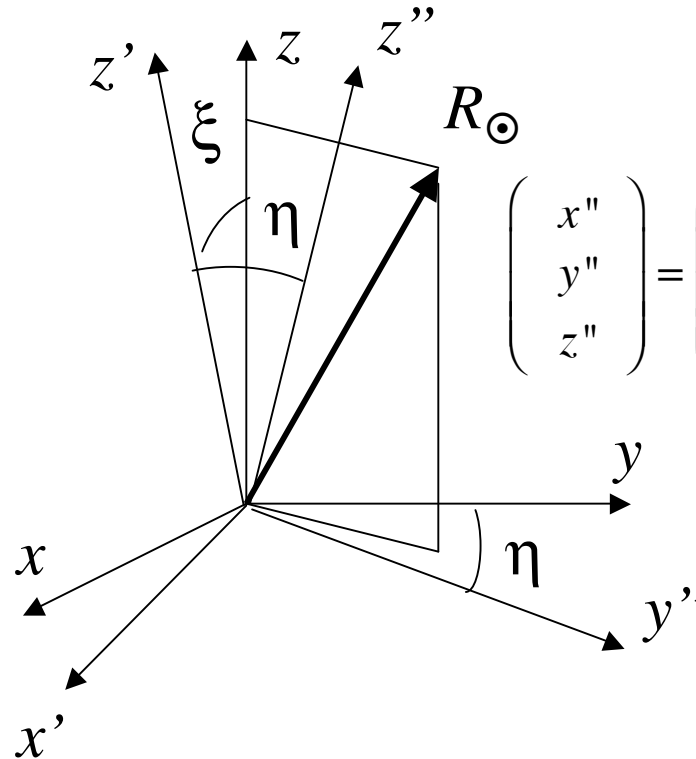
$$\begin{pmatrix} x" \\ y" \\ z" \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\eta & \sin\eta \\ 0 & -\sin\eta & \cos\eta \end{pmatrix} \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}$$

Rotate about the x'-axis by angle η
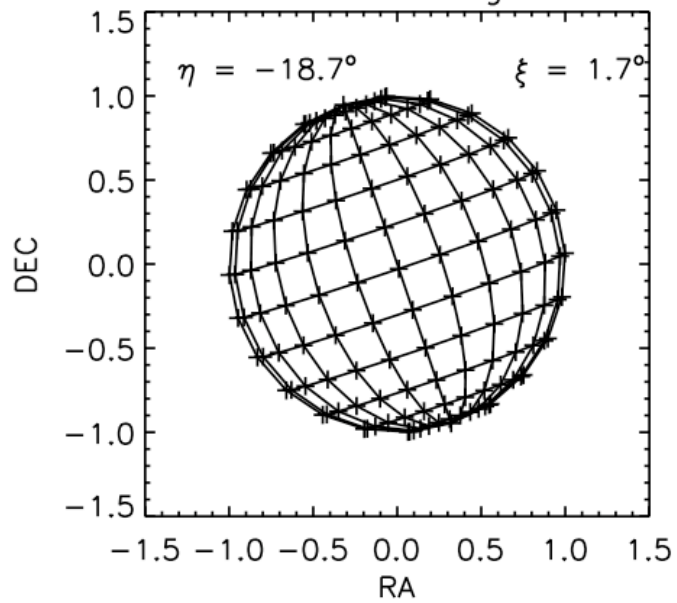
Orientation of the spin axis relative to north

Latitude & Longitude

Velocity contours

Latitude & Longitude

$\eta = -18.7°$ $\xi = 1.7°$

Velocity contours