# ITRS, Reference frames, Relativistic effects

# Introduction

- ITRS = International Terrestrial Reference System. It is the parent system for mapping and surveying all over the world. Establishment of ITRS was an enourmous challenge, and so is the maintenence. The Earth's crust is not stable, but broken into a mosaic of plates moving relative to each other. Because of elasticity of the Earth the sun and Moon make deformations of the Earth. And there are no stable axes to which a reference frame can be connected.

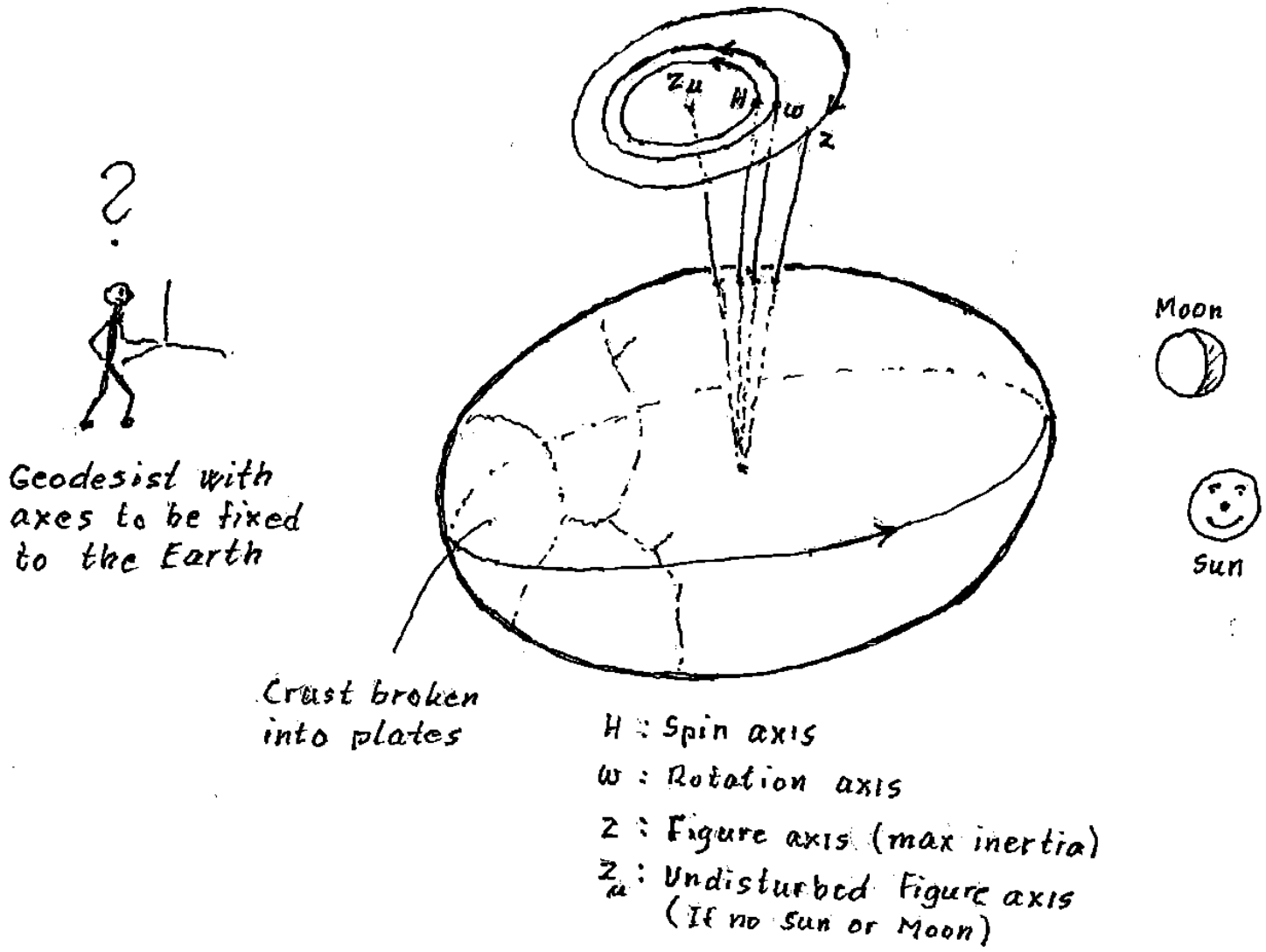


Figure 1. The rotating Earth

# IERS conventions

- The ITRS is taken care of by an organization called IERS (International Earth Rotation and Reference Frame Service). In IERS Conventions there is a list of four conditions fullfilled by ITRS. Let us consider these conditions one by one.

# Condition no. 1 for ITRS

- It is geocentric, its origin being the center of mass for the whole Earth, including oceans and atmosphere.
- Comments: This condition is well understood and as one could expect.

# Condition no. 2 for ITRS

- The unit of length is the meter (SI). The scale is consistent with the TCG time coordinate for a geocentric local frame, in agreement with IAU and IUGG (1991) resolutions. This is obtained by appropriate relativistic modeling.
- Comments: TCG can be imaged as given by a standard atomic clock at zero potential. The ITRS meter is then the length of the path traveled by light in vacuum at zero potential during a time interval of 1/299792458 of a TCG second.

# Condition no. 3 for ITRS

- Its orientation was initially given by the BIH (Bureau International de l'Heure).
- Comments: The spin axis was traced by astronomical observations at five observatories for six years, 1900 to 1905. It moves approximately in circles around the undisturbed figure axis, which then could be determined and adopted as polar axis. The orientation in longitude was connected to the Greenwich astronomical meridian.

# Condition no. 4 for ITRS

- The time evolution of the orientation is ensured by using a no-net-rotation condition with regards to horizontal tectonic motions over the whole Earth.
- Imagine the coordinates of a set of points spread around the Earth being redetermined after som time and showing coordinate differences l. Remove a possible rotation rot from l by writing
- l- rot x r = v, r=position vector
- and minimizing the sum of vv by variation of rot. v is then rotation free. Added to the old coordinates it thereby creates a new reference frame.

# Final remarks

- We have touched only a few topics concerning ITRS. The IERS conventions is a document of 165 pages of consentrated information. Few deductions are given, but there are comprehensive lists of literature references.