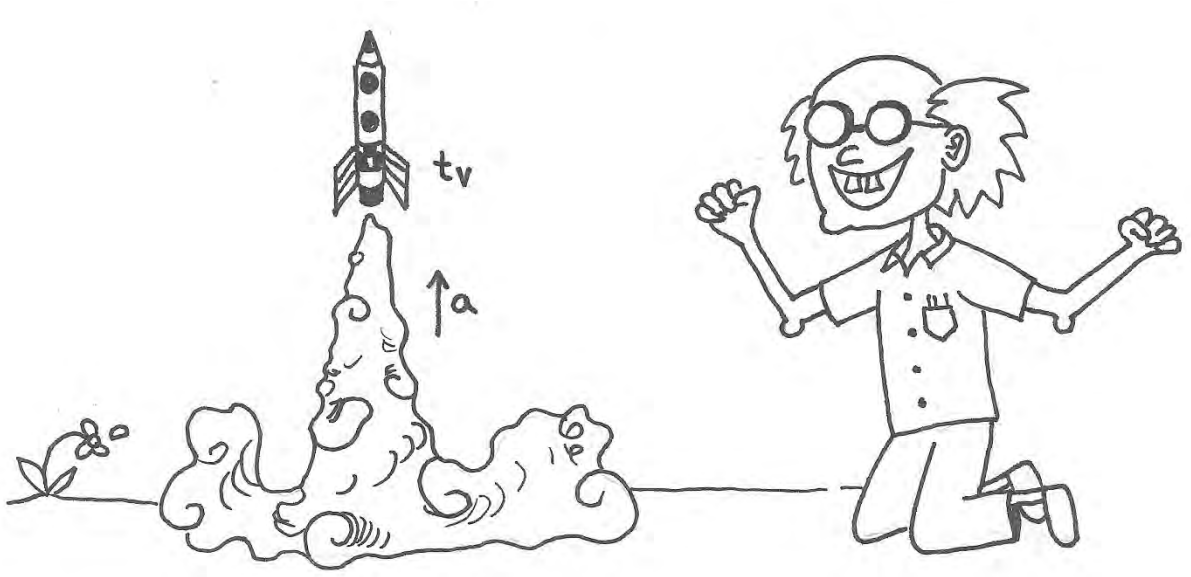
Satellites, spaceflight and universe, the amphitheatre for education

Pavol Valko, Bezovec 2023

Why to blend education with space themes?

Space Engineering Through (True) Training

- FEI STU established second-degree study program “Space Engineering”
- currently supported by ESA PECS educational project SK5 9 4000133459 20 NL SC + CCN1
- lack of adequately competent students from bachelors stage
- but quality problem continues from secondary (and primary) schools pupils
- widespread motivation deficiency

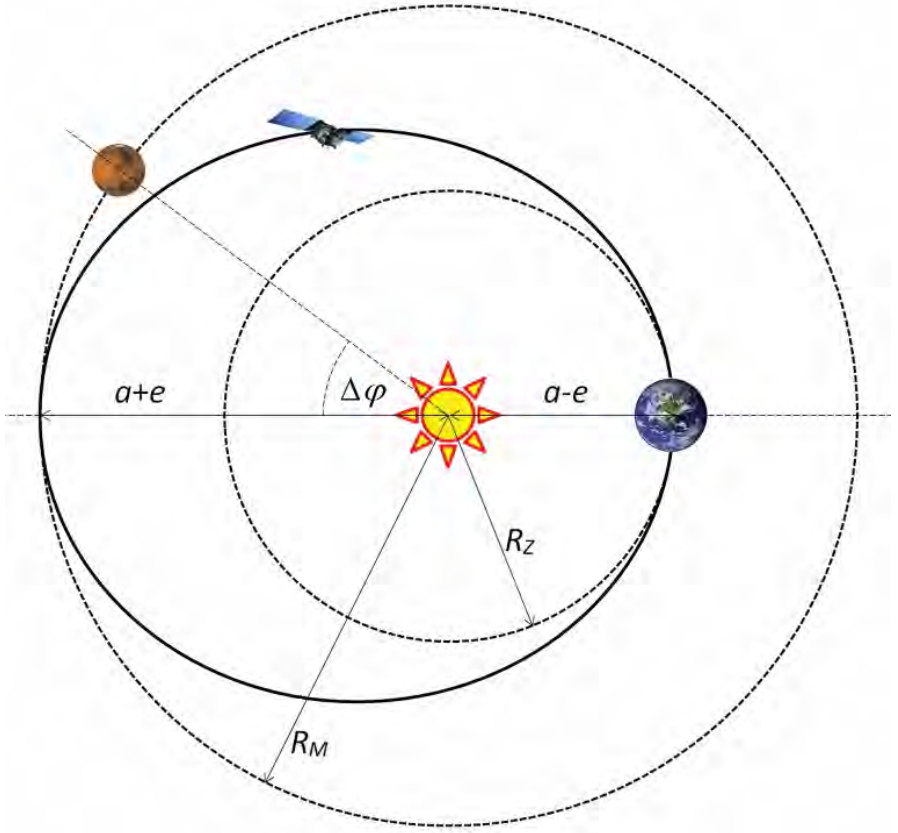


- secondary school students seems to be optimal target group to mix highly interesting “space” problems into curriculum to boost motivation and improve topics understanding

Physics & Space

- ideal subject to introduce space examples with many topics, like
  - parabolic zero g aircraft flight profile
  - circular motion
  - centripetal force and satellites motion
  - total energy in conservative fields and escape speed
  - pressure as energy density and small maneuvering “engines”
  - gravity assist maneuvers and momentum conservation
  - redshift and Doppler effect
  - Roemer’s light speed determination from Io observations

Examples



$$\Delta t_s = \frac{T_Z\, T_M}{T_M - T_Z} = 779,95\,\text{dňa} \approx 26\,\text{mesiacov}$$

Mathematics & Space

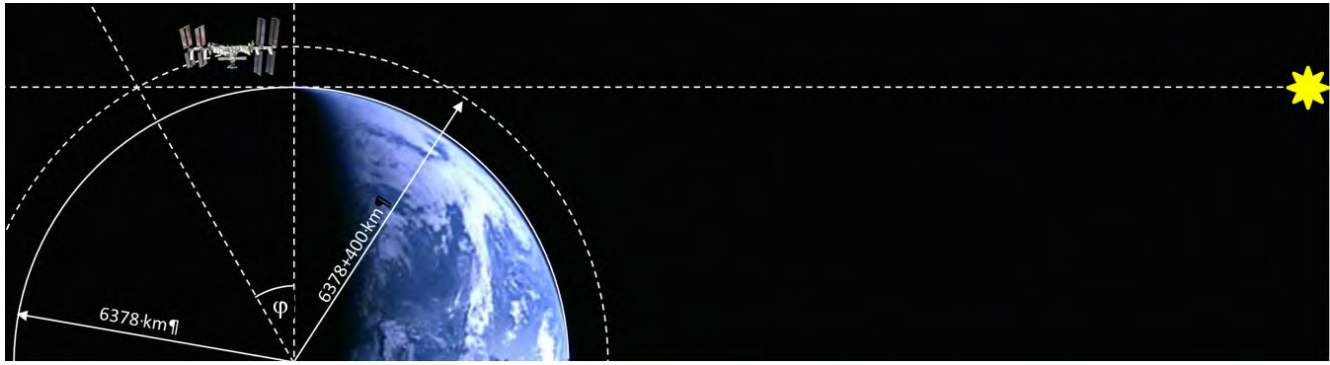
Examples

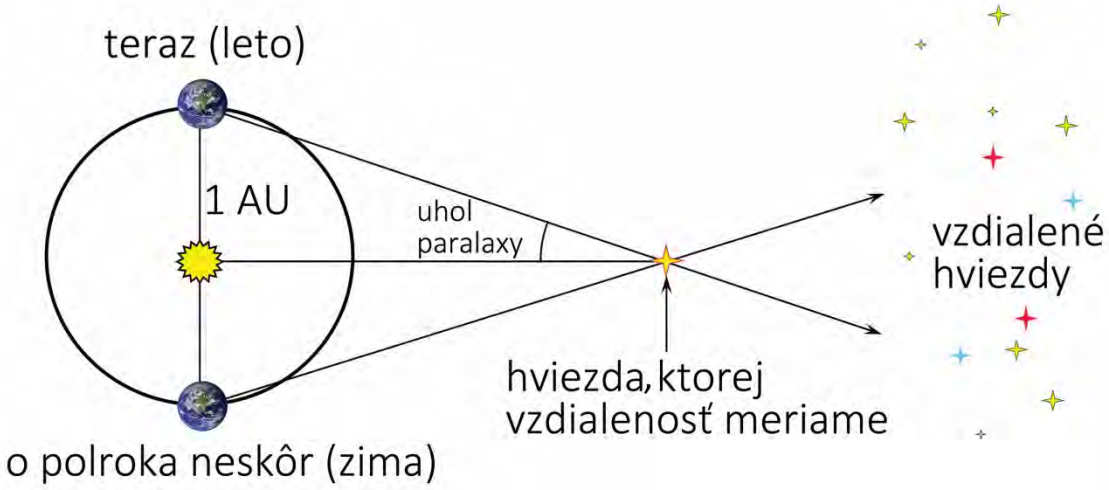
- basic geometry
  - similar and identical triangles
  - Earth diameter determination
    (as Eratosthenes did)
  - properties of logarithms and necessity of staged rockets

$$\ln a + \ln b + \ln c = \ln abc$$

  - logarithms and apparent stellar magnitude

$$m_x = -5 \log_{100} \left(\frac{F_x}{F_{x,0}} \right) \qquad m_x = -2.5 \log_{10} \left(\frac{F_x}{F_{x,0}} \right)$$





Chemistry & Space

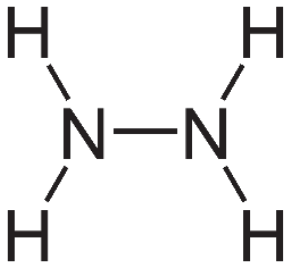
Examples

- Catalysis of hydrogen peroxide
  - V2 and R7+derivatives rockets
  - passivated storage tanks
    - chemical chain reaction

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

- Catalysis of hydrazine
  - structural formulas

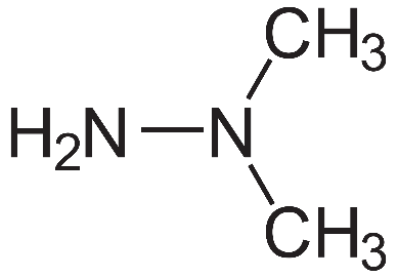
$$3N_2H_4 \rightarrow 4NH_3 + N_2$$

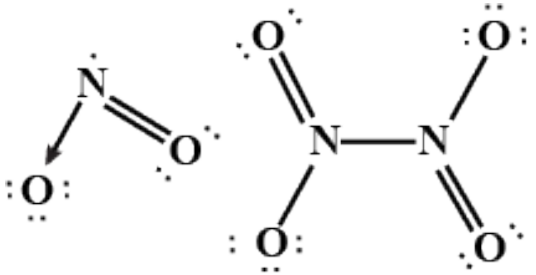


- Hydrogen and oxygen combustion
  - the size of fuel tanks

$$2H_2 + O_2 \rightarrow 2H_2O$$

- Hydrazine and its derivatives
  - methyl and dimethyl hydrazine
    - unsymmetrical dimethyl hydrazine
  - reacting with nitrogen oxide
    - nitrogen oxides dimers





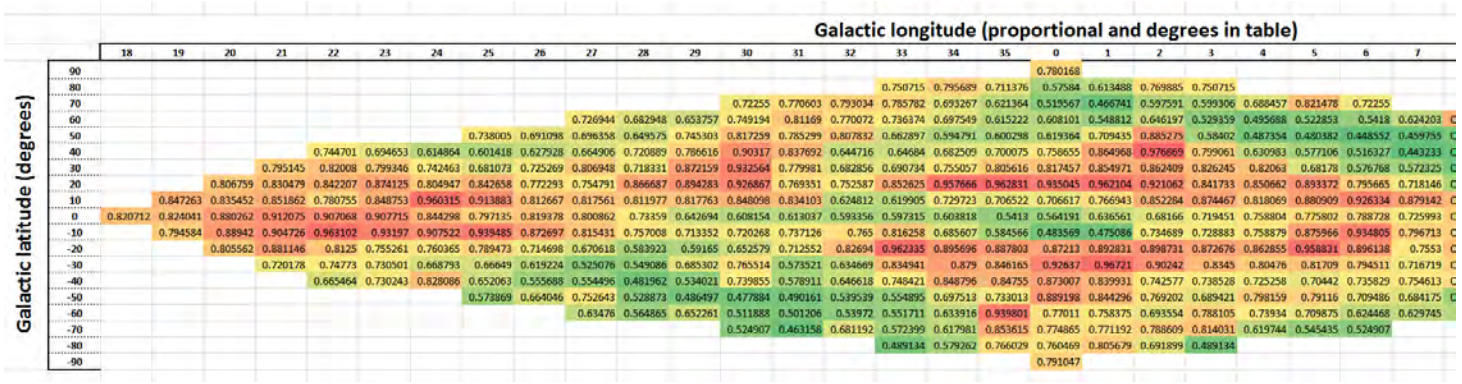
Informatics & Space

Examples

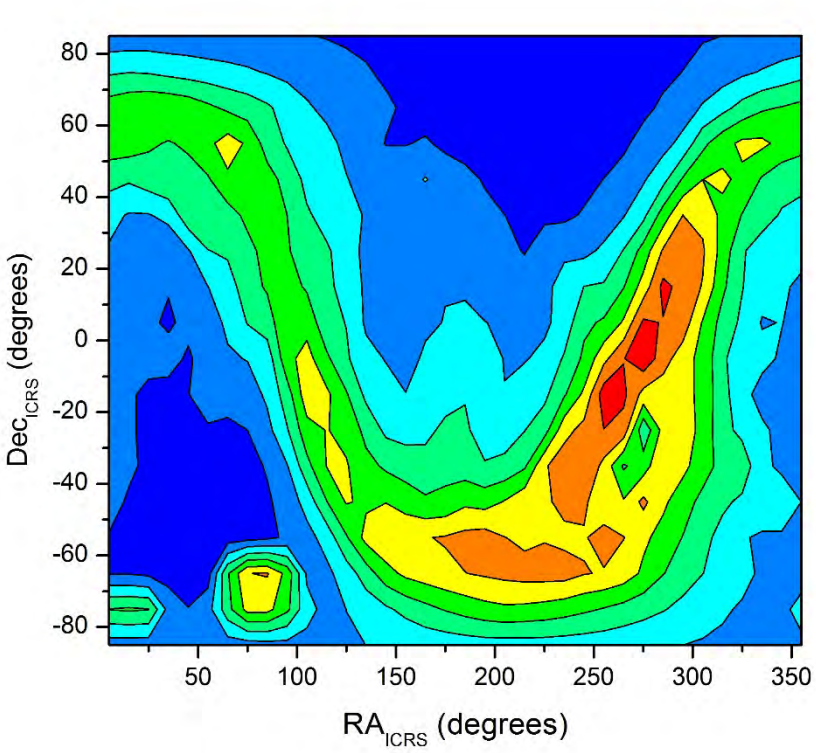
- data and databases
  - basics of SQL (or other query systems)

```
SELECT avg(parallax) AS paralaxa, avg(parallax_error) AS chyba_paralaxy, ra_valko, dec_valko
FROM gaiadr2.gaia_source, user_pvalko01.tbl_smer AS moja
WHERE  (1=CONTAINS( POINT('ICRS', ra, dec),  CIRCLE('ICRS', moja.ra_valko, moja.dec_valko, 5)) and parallax>1 and parallax <100 )
group by moja.ra_valko, moja.dec_valko
```

  - Excel data handling training is also OK



- Arduino microcomputers
  - simple automation systems
    - actively controlled equilibrium
      - as done by rockets during launch process



Is There Anybody Out There?

- Final product should contain collection of pedagogical guidelines of selected topics (max up to 50)
  - published in the form of simple booklet
  - distributed to Slovak secondary schools
- Prepared motivational topics will be translated into English and provided to ESA European Space Education Resource Office for STEM (Science, Technology, Engineering and Mathematics) education support
  - in digital form
- Participants, which will help to prepare topic texts and graphics will be financially rewarded (adequately)

Conclusions

- Anybody willing to participate is welcome
  - ideally secondary schools teachers
  - and all idealists equally

Contact:

Pavol Valko
FEI STU
Ilkovičova 3, 812 19 Bratislava

pavol.valko@stuba.sk
pavol.valko@gmail.com
tel: +421 903 130 748