Určovanie veľkosti Mesiaca s využitím fotiek mesačného zatmenia

Mgr. Patrik Čechvala, Mgr. Lucia Klinovská,
Mgr. Jana Jakubičková, Mgr. Karol Havrila
KAFZM FMFI UK, KD FMFI UK

Bezovec 2020
1.-2.10.2020

Obsah

- Predstavenie aktivity
- Implementácia aktivity počas vyučovacieho procesu na strednej škole – Gymnázium Metodova
- AstroEdu konferencia – Garching, 2019

Motivácia

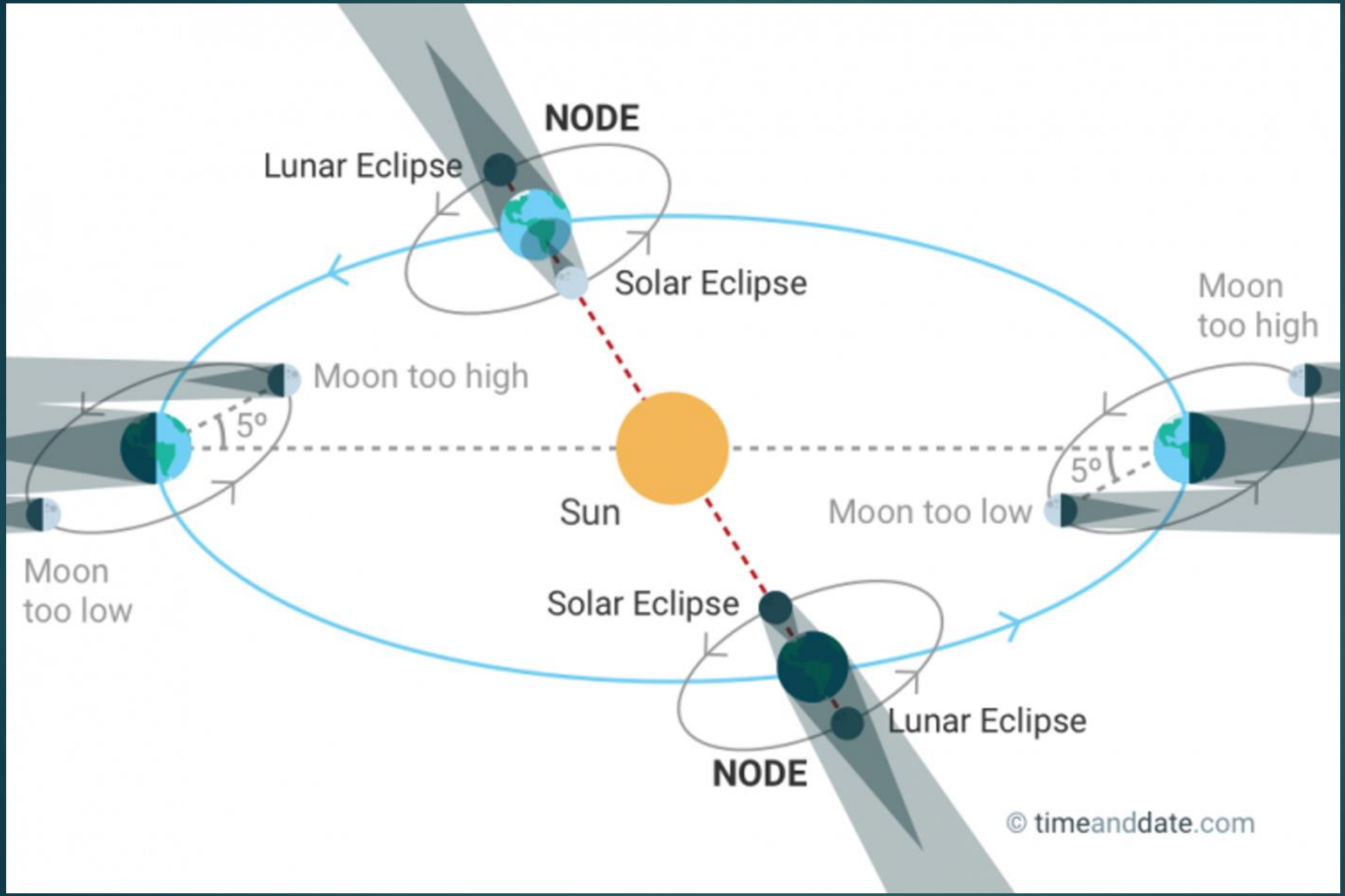
- Slovenský štátny vzdelávací program pre fyziku prakticky neobsahuje témy z astronómie
- Slnečná sústava, pohyby Zeme a pohyb Zeme okolo Slnka – žiaci preberajú vo veku 8-10 rokov na Prírodovede
- Spôsob ako vniesť astronomické témy do vyučovacieho procesu – hodiny matematiky

Určovanie veľkosti Mesiaca s využitím fotiek mesačného zatmenia

- Vhodné pre žiakov vo veku 13-14 rokov – oboznámení s konštrukciou kruhu pomocou 3 bodov, pomermi

- Potrebné pomôcky pre študentov –
    - ceruzka, krúžidlo, pravítko, farebné ceruzky a perá

- 2 spôsoby riešenia – rysovanie priamo na papieri alebo využijúc software GeoGebra

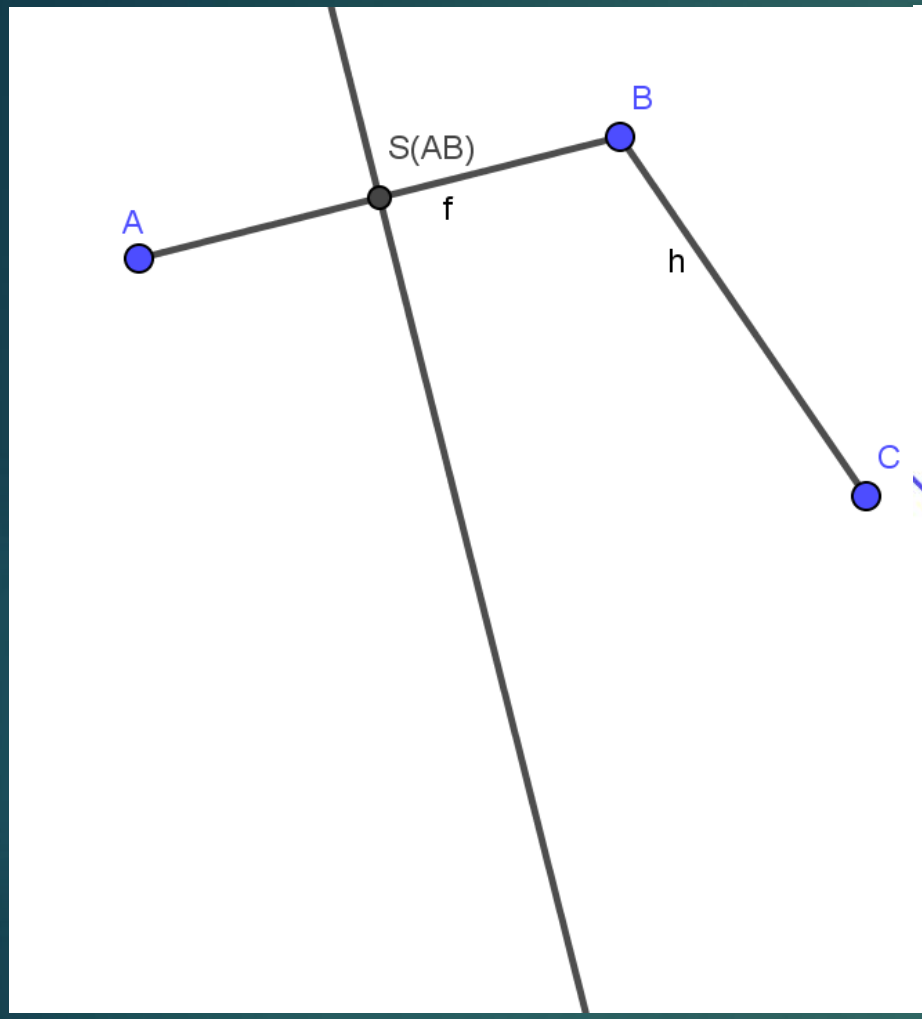


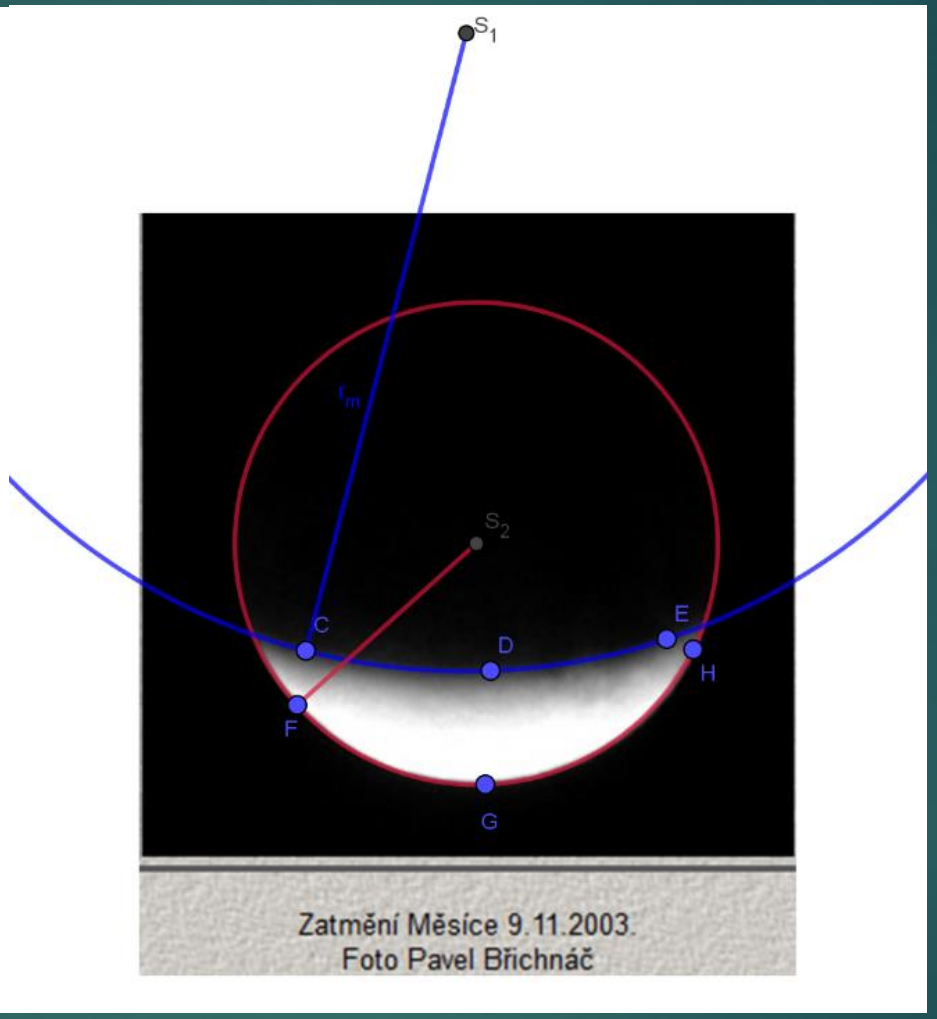
https://www.timeanddate.com/eclipse/partial-solar-eclipse.html

Foto: Roman Vaňúr, 21.1.2019

Smerujúce otázky:

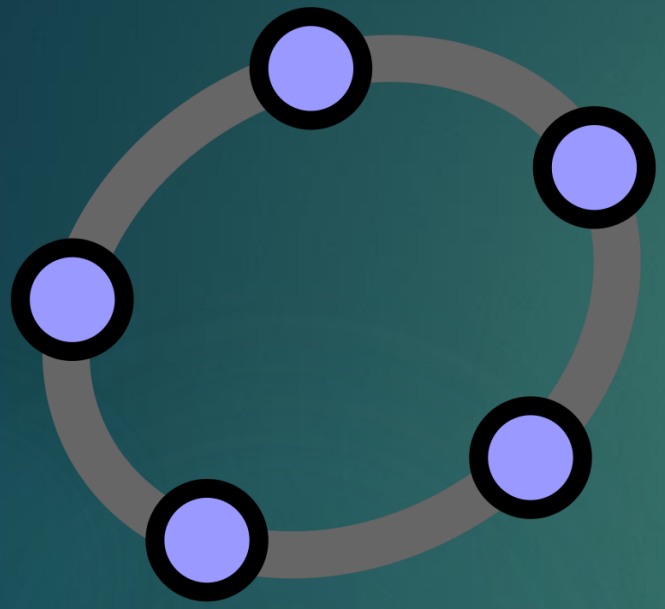
1. Aký jav je možné vidieť na fotografii?
2. Aký je základ tohto javu? Ktoré nebeské objekty môžeme vidieť na fotografii?
3. Aké geometrické útvary sa nachádzajú na fotografii?
4. Sme schopní tieto útvary nakresliť?
5. Aké sú vlastnosti kruhu, ktoré môžu byť použité pre riešenie problému?
6. Ako by bolo možné určiť veľkosť skutočného mesačného polomeru s využitím odmeraného polomeru a vediac skutočnú skutočnú veľkosť zemského polomeru?



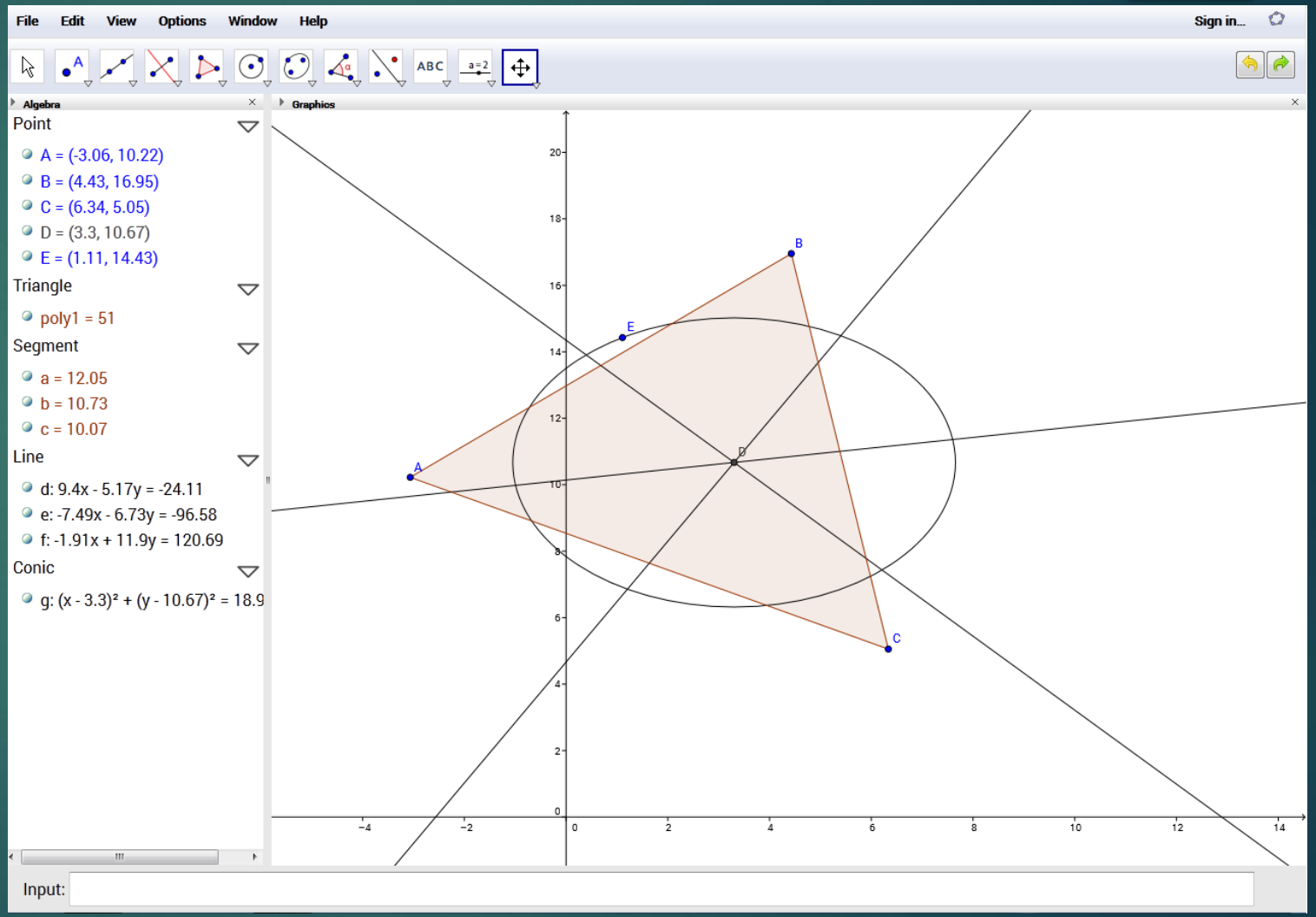


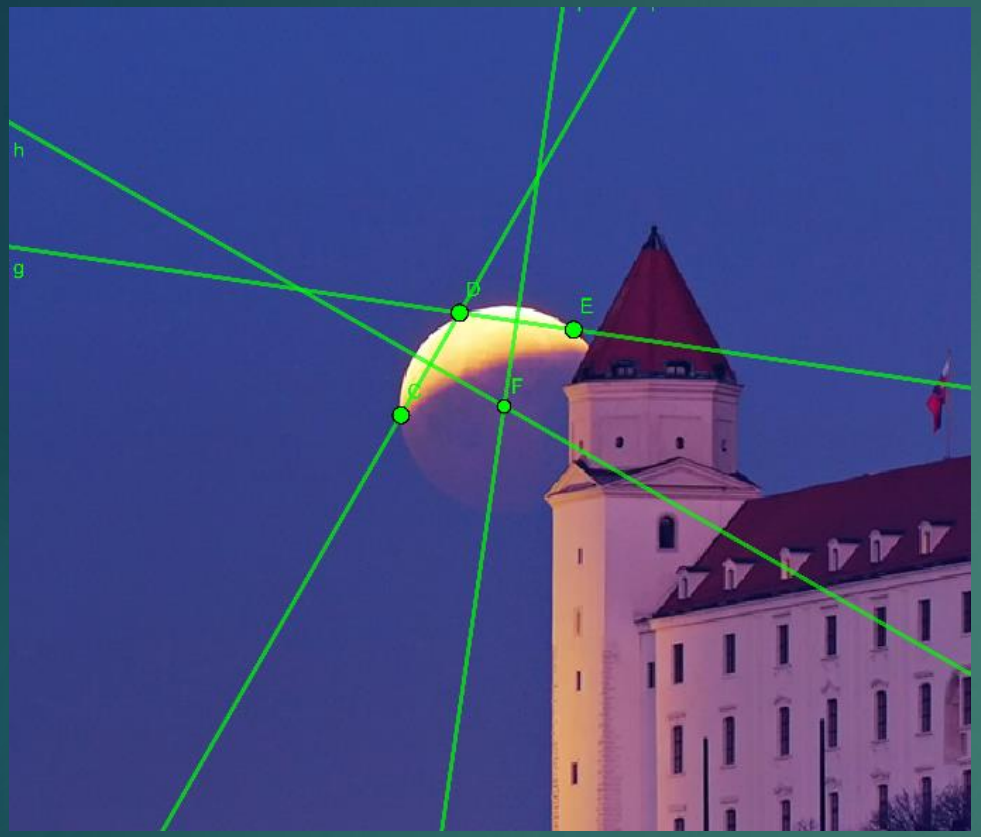
Zatmění Měsíce 9.11.2003.
Foto Pavel Břichnáč

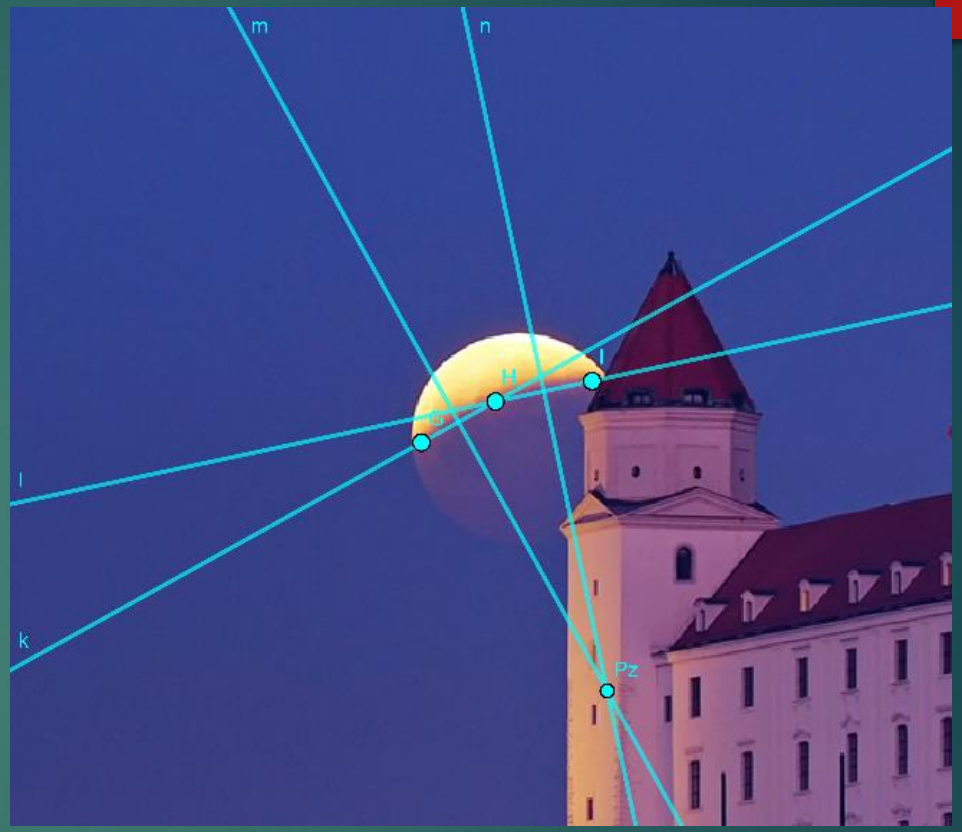
GeoGebra software



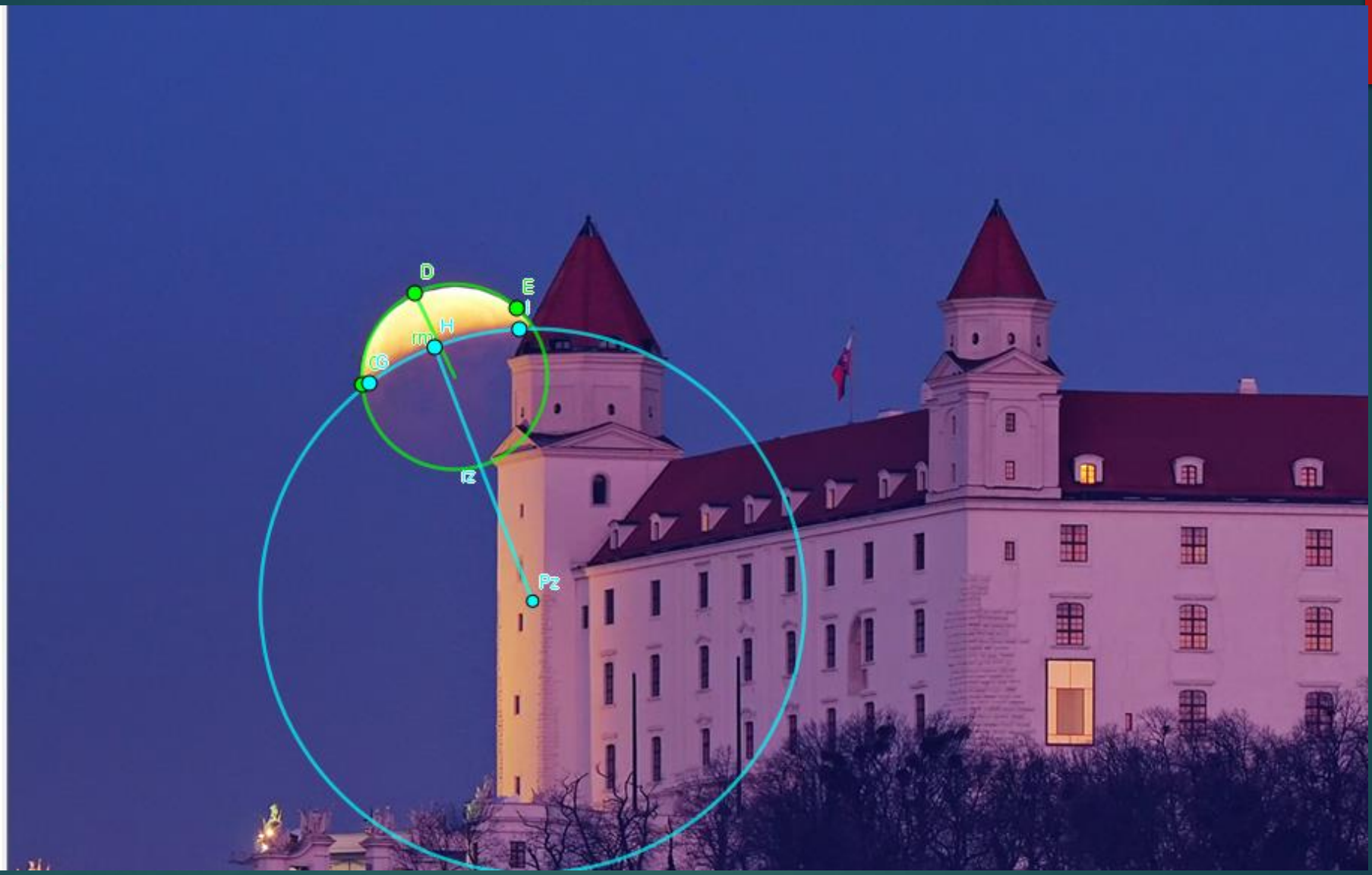
https://www.geogebra.org




h
g
D
E
C
F


m
n
H
I
l
k
Pz

- A = (-4.28, -6.3)
- B = (17.02, -6.16)
- C = (3.73, 0.86)
- D = (3.93, 1.2)
- E = (4.31, 1.15)
- f: -0.34x + 0.2y = -1.11
- g: 0.06x + 0.38y = 0.68
- h: -0.2x - 0.34y = -1.11
- i: -0.38x + 0.06y = -1.51
- F = (4.08, 0.89)
- c: (x - 4.08)² + (y - 0.89)² = 0.12
- rm = 0.35
- S = (3.78, 0.86)
- H = (4, 1)
- I = (4.32, 1.07)
- k: -0.14x + 0.24y = -0.3
- l: -0.07x + 0.32y = 0.05
- m: -0.24x - 0.14y = -1.07
- n: -0.32x - 0.07y = -1.39
- Pz = (4.37, 0.05)
- d: (x - 4.37)² + (y - 0.05)² = 1.04
- rz = 1.02



Riešiť rovnicu

$$\frac{R_Z}{R_M} = \frac{r_Z}{r_M}$$

$$R_M = R_Z \frac{r_M}{r_Z}$$

, kde R_Z a R_M predstavujú skutočný polomer Zeme, resp. Mesiaca a r_Z a r_M predstavujú polomery získané analýzov fotografie

- Výsledky mierne nadhodnotené

Aktivita – študenti 2. ročník, Gymnázium Metodova, 22.9.2020

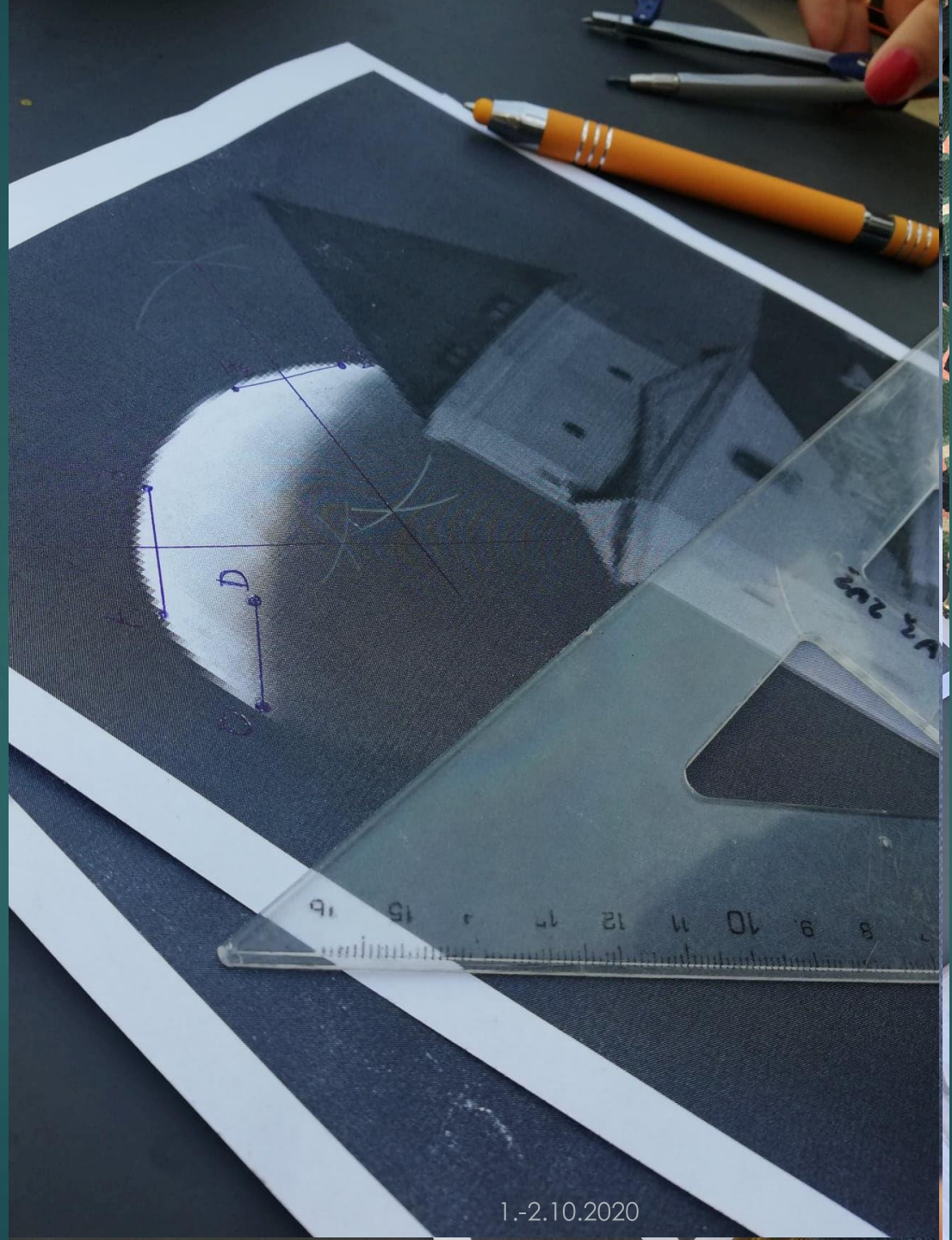


Foto: Lucia Klinovská, študenti Gymnázium Metodova

Reakcie študentov 2. ročníka gymnázia na aktivitu

- Veľmi zaujímavá aktivita z praktického života. Je to určite zábavnejšie ako počítanie rovníc.
- Podľa mňa je to vhodné napríklad na rozdeľovacie skúšky do matematickej triedy alebo tak, ale na Testovanie 9 asi nie. Lebo napríklad my sme sa o tetivách na ZŠ vôbec neučili.
- Aktivita sa nám celkom páčila, bolo to oživenie vyučovania, bolo super, že sme boli vonku. No nabudúce by som asi aktivitu vysvetlila ešte v triede, kde je ticho a nič nás nevyrušuje, až po vysvetlení by som išla von, kde by sme to všetci už len rysovali. Mali sme chaos, prerábali sme to a bohužiaľ ani na druhý pokus nám to nevyšlo úplne presne.
- Hodina sa mi veľmi páčila. Je super, využiť veci, ktoré sme sa učili v praxi alebo učiť sa iným spôsobom ako v triede pri tabuli. Rád si vyskúšam niečo podobné aj nabudúce.
- Bolo to super, určite by bolo super častejšie robiť takéto zaujímavosti.
- Zaujímavé oživenie hodiny.
- Chceli by sme dodať, že sa nám hodina páčila a radi by sme mali takýchto viac, keďže na väčšine hodín v rozvrhu iba sedíme a počúvame, tak takýto spôsob výučby s otvorenou náručou vítame.

AstroEdu Conference

16.-18.9.2019

ESO Supernova, Garching


ESO Supernova
Planetarium & Visitor Centre

The determination of the size of the Moon using lunar eclipse photos

Jana Jakubičková, Lucia Klinovská, Patrik Čechvala, Karol Havrila
jakubickajana@gmail.com, klinoska.l@gmail.com, patrik.cechvala@fmph.uniba.sk, karol.havrila@fmph.uniba.sk
Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Slovakia

Introduction

The Slovak state education programme for physics does not contain topics from astronomy. Pupils learn about the Solar system, Earth's rotation and movement of the Earth around the Sun on the age level 8 – 10 years in biology lessons [1]. One way how to implement astronomy themes in the education process is to include the specific parts of astronomy in mathematics lessons. The activity *The determination of the size of the Moon using lunar eclipse photos* (based on original concept proposed by ancient Greeks) was prepared for mathematics lessons on the age level 13 – 14 years, when pupils solve ratios and proportions and when they are familiar with the construction of circle defined by 3 points. The benefits of the activity are the connection of mathematics with astronomy, the application of mathematical procedures in the context of astronomy and obtaining new information about the Moon.

The activity is based on the analysis of the partial lunar eclipse (Figure 1).

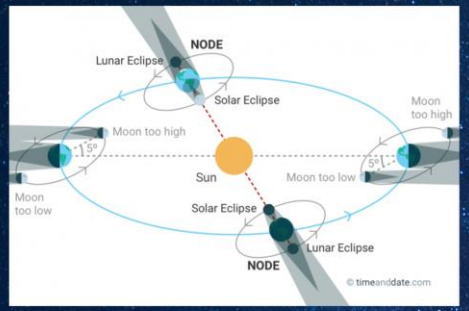


Figure 1: Simplified illustration of the creation of eclipses. Font: timeanddate.com

Activity

- The teacher shows the photo of the lunar eclipse (Figure 2a, 2b) and discusses the phenomenon in the photography with pupils.
- Discussion about the basic movements of solar system bodies and the conditions of the lunar eclipse creation. The teacher pinpoints that this can happen only during full Moon and maintains 3-dimensional visualization.
- After the discussion, the pupils get the photography of the partial lunar eclipse (we recommend to prepare the worksheets).
- Tools for the activity: pencils (also coloured), pens, compass, ruler
- The teacher asks guiding questions which do not reveal the solution, but direct the pupils in the right way:
  - What phenomenon is possible to see in the photography? (1)
  - What is the essence of the phenomenon? Which celestial objects can we see in the photography? (2)
  - What are the geometrical objects in the photography? (3)
  - Are we capable to draw these objects? (4)
  - What are the properties of the circle which can be used for problem solving? (5)
  - How would it be possible to determine the value of the real lunar radius using the measured radii and knowing the actual radius of the Earth? (6)

Figure 2: a) Partial lunar eclipse with the panorama of Bratislava castle, Slovakia, observed on 21.01.2019. Photo: Roman Vaňúr b) Partial lunar eclipse observed from Japan in 2012. Credit: https://www.zmescience.com

- Problem solving requires to apply the knowledge of geometry of circle.
- Pupils´ task is to find 3 points on the border of the lunar disc and of Earth´s shadow.
- They find the centers of these circles.
- They measure the radii of the circles.
- Using the equation (1) they determine the actual radius of the Moon R_M

$$R_M = R_E \frac{r_M}{r_E} \qquad (1)$$

- where r_M, r_E represent the measured radii of the Moon and the Earth from the photo respectively and R_E is the real radius of the Earth

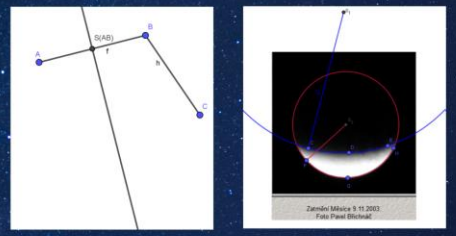


Figure 3: Searching for the center of the circle using 3 known points (left) and its application on the photography of the partial lunar eclipse (right).

Analysis using GeoGebra software

Alternative way of the solution would be using the GeoGebra software. It is an interactive geometry, algebra, statistics and calculus application, intended for learning and teaching mathematics and scienceand is applied in the education process. The advantage is faster and more precise solution of the activity. If the pupils are not familiar with GeoGebra environment, it could be used by the teacher as an illustrative example (Figure 4).

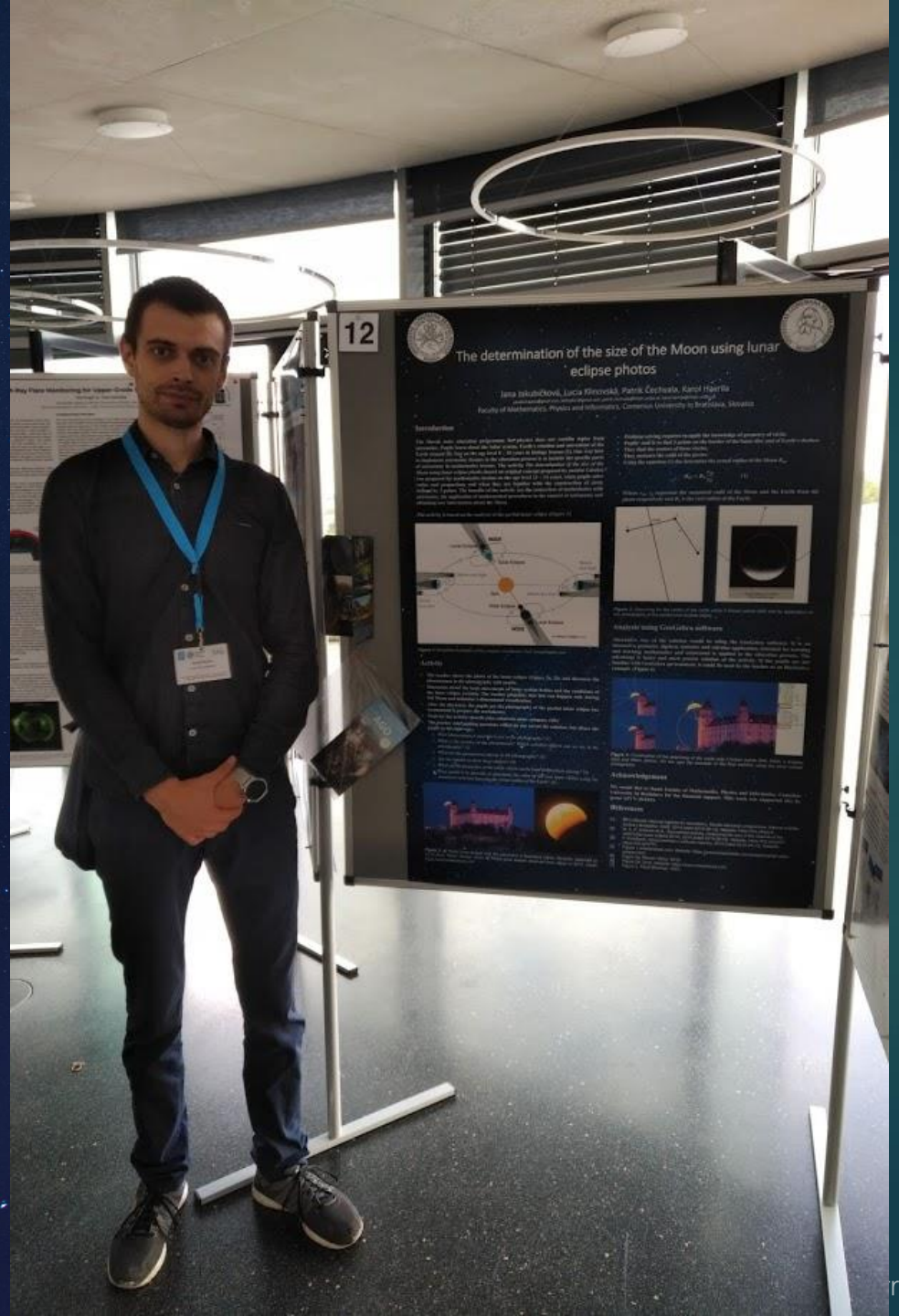
Figure 4: Construction of the searching of the circle usig 3 known points (left), Earth´s shadow (top) and Moon (down). On the right the example of the final solution using the lunar eclipse photography.

Acknowledgement

We would like to thank Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava for the financial support. This work was supported also by grant APVV-18-0103.

References

[1] ŠPÚ (Slovak national institute for education). *Slovak education programme: Natural science - [online.] Bratislava: ŠNÉ, 2014 [cited 2019-09-12]. Website:* http://www.statpedu.sk/files/articles/dokumenty/inovovany-statny-vzdelavaci-program/prirodoveda_pv_2014.pdf?fbclid=IwAR0FW0aMK2-IhwUBjY5adkqrawyHgsaIH1oCce5f2HrPL3defrIs2bLhA98
[2] M. Á. P. Jiménez et al., Educational activity, measuring the size of the shadow of the earth (total lunar eclipse 2014), 2014 *[cited 2019-09-12].* Website: https://gloria-project.eu/wp-content/uploads/2014/04/2014lunar-eclipse-crater-shadows-en.pdf
[3] F. Kundracik, Vývoj predstáv o veľkosti vesmíru, 2015 [cited 2019-09-12]. Website: https://www.youtube.com/watch?v=yvE-4FASwwI&fbclid=IwAR1km6o4zN8lqHJK4dc0nD77EmYlsArIxOfSmS-V4nskNVoMxZ9xkBbBOZo
[4] Figure 1, timeanddate.com. Website: https://www.timeanddate.com/eclipse/partial-solar-eclipse.html
[5] Figure 2a, Roman Vaňúr, 2019.
[6] Figure 2b, 2012, Website: https://www.zmescience.com
[7] Figure 3, Pavel Břichnáč, 2003



Bibliografické odkazy

- ŠP□Ú (Štátny pedagogický ústav). Slovenský vzdelávací program: Prírodné vedy [online.] Bratislava: SNIE, 2014 [cited 2019-09-12].
- F. Kundracik. Vývoj predstáv o veľkosti slnečnej sústavy a žiacke experimenty, 2015 [cited 2019-09-12]. https://www.youtube.com/watch?v=yvE-4FASwwI&fbclid= IwAR1km6o4zN8lqHUK4dc0nD77EmYlsArlxOfSmS-V4nskNVoMxZ9xkBbBOZo.
- M. Á. P. Jiménez. Educational activity, measuring the size of the shadow of the earth (total lunar eclipse 2014). https://gloria-project.eu/wp-content/uploads/2014/04/2014lunar-eclipse-crater-shadows-en.pdf

Poďakovanie

Práca bola podporená grantom Agentúry na podporu výskumu a vývoja APVV-18-0103.

Ďakujem za pozornosť