A NEW FORM OF SPACE SCIENCE EDUCATION: PREPARATIONS FOR PHOENIX LANDER MISSION SIMULATIONS BY HUNVEYOR IN TERRESTRIAL CONDITIONS.

Szikra I.[1], ***Ferenczi Gy.***[1], ***Varga T.***[2], ***Darányi I.***[2], ***Hudoba Gy.***[3], ***Földi T.***[4], ***Hegyi S.***[5], ***Bérczi Sz.***[6]. [1]Thormed Ltd., H-1182 Budapest, Petőfi u. 30., Hungary (thormed@thormed.com), [2]VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20., Hungary (info@vtpatent.hu), [3]Budapest Polytechnik Kandó Kálmán Faculty of Electrical Engineering, Inst. of Computer Technology, H-8000 Székesfehérvár, Budai út 45., Hungary, [4]FOELDIX, H-1117 Budapest, Irinyi J. u. 36/b. Hungary, [5]Pécs University, Faculty of Science, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6, Hungary, [6]Eötvös University, Institute of Physics, Dept. G. Physics, Cosmic Materials Space Research Group, Budapest, Pázmány 1/a, Hungary.

Introduction: Because of planned touch down of the Phoenix Lander on northern plains of Mars in June, 2008 we began a simulation program in our planetary science education. We prepare Hunveyor as a modeling probe for simulations of some works which is planned on Phoenix. First we show planetary atmospheric measuring instruments. We intend to carry out simulations in terrestrial conditions, but principles and methods will be analogous.

Atmospheric measuring instruments on Phoenix-Hunveyor: The purpose of this work not only to build instrumentations but to show a method for planetary science experiment from the principle through a simple experiment, then planning and building an instrument by students onto a space probe. The main steps first are shown on an example simple experiment how to measure the speed of streaming air in a windy planetary atmosphere by the principle of sonic anemometry. This method gives grades for students to reach more developed instruments [1-3].

Principle and a basic simple experiment: First we modeled it with students in a large scale physical environment. Streaming air masses transport the medium which is oscillating by the impulses of sounds. In a simple experimental arrangement four students are standing at the vortices of a square.

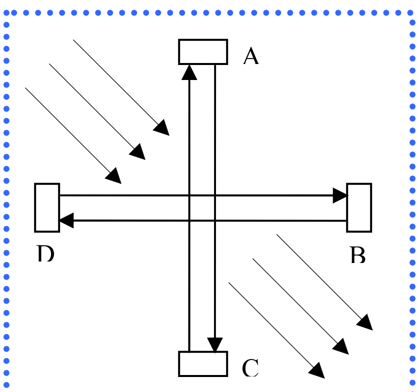

Fig. 1. This is a simple experiment with 4 students standing at the corners of a square in a symmetric arrangement. Streaming air transports sonic waves. 2D (in the plane) measuring arrangement.

Light and sonic signal is emitted by all 4 students (i.e. shooting). They are also observers. They are measuring the starting time point of 1) first light, then 2) the sonic signal of the student in front of them. Intervals between light and sonic signal are shorter for B and C observers, than intervals for the A and D observers, because moving air masses added (for B and C) or subtracted (A and D) a speed component to or from the speed of sonic waves in the air.

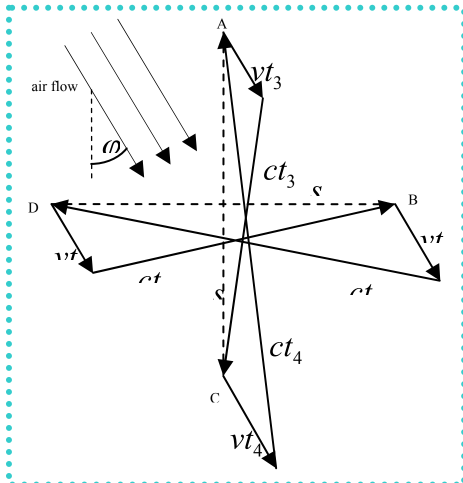

Fig. 2. Signal sources seem to have been moved according to the wind's air mass movement, by equal direction vectors. Signal running times should be compared for calculating the wind' speed.

A measuring arrangement may use benefits of the geometry: sonic emitter and the two sensors are arranged in a V form. The signals of the E emitter arrive to the two sensors at P and Q (Fig. 2.) For t_1 and t_2 time points the triangles can be formulated by the cosines theorem, as given: for Q:

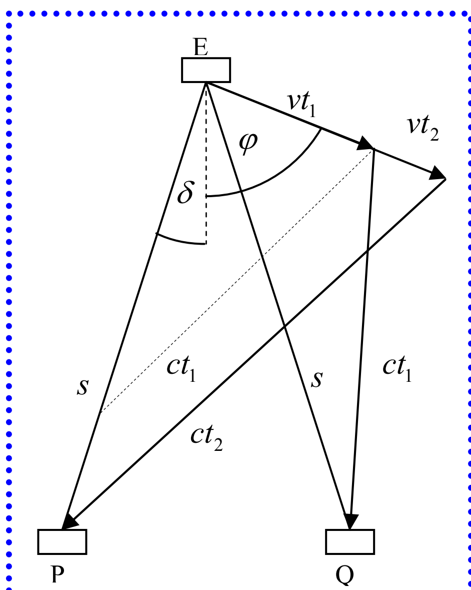

Fig. 3. This is a V geometry arrangement with one emitter (virtual sonic source E) and two (P and Q) sensors. Here S is the length of the equal edge of V triangle, c is the sonic speed and v is the speed of the streaming air.

$$(ct_1)^2 = (vt_1)^2 + s^2 - 2svt_1\cos(\varphi - \delta)$$

and for P:

$$(ct_2)^2 = (vt_2)^2 + s^2 - 2svt_2\cos(\varphi + \delta)$$

From the two equations the speed of the streaming air can be expressed:

$$v = \frac{s}{2}\frac{(t_2 - t_1)(t_2 + t_1)}{t_2 t_1 (t_2\cos(\varphi - \delta) - t_1\cos(\varphi + \delta))}$$

If the sides of the equal sided triangle is opened to have 180 degree angle, the two opposite observers case is given. The final formula for the 4 observers in this way is:

$$v = \frac{s(t_2 - t_1)}{2t_1 t_2 \sin(\varphi)} = sign(t_1 t_2 - t_3{}^2)\frac{s\sqrt{(t_1 t_2 - t_3{}^2)^2 + (t_2 - t_1)^2 t_3{}^2}}{2t_1 t_2 t_3}$$

and

$$\tan(\varphi) = \frac{(t_2 - t_1)t_3}{t_1 t_2 - t_3{}^2}$$

Hunveyor as the modeling probe for planetary atmospheric measurements on the surface of Mars: Hunveyor is a student developed experimental space probe model. We build various instruments on them. For Phoenix-Hunveyor package the dust collector is an important instrument. It is partly related to the electrostatic measurements.

In this dust collector (named Foeldix by professor Földi, Eötvös University) special electrodes and their arrangement allow that the streaming airflow through the instrument should be coagulated. The dust and other complex particles precipitate and sediment from the streaming particles in the instrument [4-5].

Fig. 4. The dust collector Foeldix on Hunveyor. Space Day 2003, Budapest.

Coagulation is made more effective because of the presence of the negatively charged water molecules on the surface of dust particles (both in Mars and on the Earth). The coagulated materials may contain even various bacterial components, too (both in Mars and on the Earth) [6-7]. We plan to carry out the experiments with the instruments in the Great Hungarian Plain. There dry alkaline grounds can be found, (especially in Hortobágy puszta). Hortobágy is also adequate place for Mars analog studies because dust devils can emerge there in summer hot windy days.

Other wind measuring instruments of Hunveyor: The Hunveyor-4 is equipped model with wind instruments [8].

Fig. 5. Wind direction and strength instruments on Hunveyor-4 of Székesfehérvár.

Summary: We are preparing with the 4 Hunveyors (recently in construction at various Hungarian universities and colleges) to model simulations of some works which is planned on Phoenix to be landed on Mars in 2008 (here with planetary atmospheric measuring instruments). This is using programs shown in our concise atlases about the planetary microenvironment studies [9]. We intend to carry out simulations in terrestrial conditions in the Hungarian Plain. First we visited Fülöpháza moving dunes region in 2005 August.

Acknowledgments: This work has been partly supported by the MUI-TP-190/2005 fund.

References: [1] Williams, J.-P. (2001): Acoustic environment of the Martian surface. *Journal of Geophysical Research*, **106**, E3, p. 5033-5042, [2] Merrison, J. P.; Gunnlaugsson, H. P.; Jensen, J.; Kinch,K.; Nørnberg, P.; Rasmussen, K. R. (2004): A miniature laser anemometer for measurement of wind speed and dust suspension on Mars. *Planetary and Space Science*, **52**, 13, p. 1177-1186, [3] Cuerva, A.; Sanz-Andrés, A. (2005): Sonic anemometry of planetary atmospheres. *Journal of Geophysical Research* (Planets), **108**, E4, pp. 10-1, [4] T. Földi, Sz. Bérczi (2002): Electrostatic Modelling of the Lunar Soil - How Electrostatic Processes in the Lunar Dust May Generate the Ion-Cloud Levitating above the Surface on the Moon - Experiments in a Model Instrument. *Acta Mineralogica et Petrographica, Szeged*, **XLIII**. 55-58; [5] T. Földi, Sz. Bérczi, E. Palásti (2002): Time Dependent Dust Size Spectrometry (DUSIS) Experiment: Applications in Interplanetary Space and in Planetary Atmospheres/Surfaces on Hunveyor. *Meteoritics & Planetary Science,* **37**, No. 7. Supplement, p. A49; [6] T. Földi, Sz. Bérczi, E. Palásti (2003): Experimental Instrument on Hunveyor for Collecting Bacteria by Their Electrostatic Coagulation with Dust Grains (FOELDIX): Observation of Electrostatical Precipitated Coagulated Units in a Nutrient Detector Pattern. *Acta Mineralogica et Petrographica, Szeged*, **XLIV**. 19-22; [7] T. Földi, Sz. Bérczi (2004): Collecting bacteria together with aerosols in the Martian atmosphere by the foeldix experimental instrument developed with a nutrient detector pattern: model measurements of effectivity. *LPSC XXXV*, #1059, LPI, Houston; [8] Hudoba, Gy., Sasvári G., Kerese P., Kiss Sz., Bérczi Sz. (2003): Hunveyor-4 Construction at Kandó Kálmán Engineering Faculty of Budapest Polytechnik, Székesfehérvár, Hungary. In *LPSC XXXIV*, #1543, LPI, Houston; [9] Mörtl M., Földi T., Hargitai H., Hegyi S., Illés E., Hudoba Gy., Kovács Zs., Kereszturi A., Sik A., Józsa S., Szakmány Gy., Weidinger T., Toth Sz., Fabriczy A., Bérczi Sz. (2004): Unusual guidebook to terrestrial field work studies: microenvironmental studies by landers on planetary surfaces (new atlas in the series of the Solar System notebooks on Eötvös University, Hungary). *LPSC XXXV*, #1214.