LONG LIFE AIRSHIP PROBE FOR THE APPLICATION IN THE ATMOSPHERE OF TITAN WITH THE UTILIZATION OF ND TECHNOLOGY. *I. Nehéz[1], T. Varga[2], I. Szilágyi[2], Sz. Bérczi[3], T. N. Varga[4].* [1]Nehéz Balloon Project, H-8500 Pápa, Korona u. 16. (nehezimre@kabelszat2002.hu), [2]VTPatent Agency, H-1111 Budapest, Bertalan L. u. 20. (info@vtpatent.hu), [3]Eötvös University, H-1117 Budapest, Pázmány P. sétány 1/a. (berczi szani@ludens.elte.hu), [4]Eötvös József High School, H-2890 Tata, Tanoda tér 5. (mirene@freemail.hu), Hungary

Summary: The subject of the proposal is a Lighter Than Atmosphere (LTA) exploring airship probe, which, when drifting in the atmosphere of Titan can make observations for a long time with utilizing Nil Diffusion (ND) technology and a special structure [1]. The airship probe is able to advance using the Hadley cell circulation system of the Titan atmosphere [2].

Background of the problem to be solved: In exploration of planets and their moons the observations most frequently takes place from orbit and/or from mobile units, rovers landed on surface, respectively from surface mobile units starting from the surface. It is not very common to make observations, measuring, from units flying above the surface. In such cases the exploration of the environment close to the surface or in the cases when the circumstances for surface landing on the planet/moon are not favourable launching of an airship probe might be needed. Earlier a balloon exploring device launched from an orbiter was used in exploring Venus in the Vega project, and such project for Mars was also considered as well.

A probe flying above the surface in a given height might be suitable device for optical observation of proper quality, and it can offer to unify the advantages of an orbiter observing unit and a surface probe as well. Launching of such a flying probe is possible directly from the orbiter unit into the atmosphere of a planetary body. The launching probe to the atmosphere is also possible from an unit, which already landed on the surface. From the point of view of research it is crucial, that the probe in the atmosphere should be able to function for a long time.

In case of the recent balloon technology one of the main problems is, that the life expectancy of the ballon is relatively short, resulting on a short functioning period for the probe. One of the physical causes of this phenomenon is, that due to normal and partial diffusion occuring with balloons, the probe filled with gas becomes heavy and so it looses its flying ability.

General conditions of Titan: Distance from Saturn: 1,221,830 km, Diameter: 5,150 km, Density: 1.88 g/cm^3, Gravitational accelaration: 1,314 m/s^2, Escape velocity: 2,639 km/s. Components of the atmosphere of Titan: 85-95% nitrogen, 5-10% argon, 1-5% methane, other compounds: hydrocarbons, nitriles, H_2O and CO_2. Thickness of atmosphere: max. 800 km, Surface pressure: 1.5 bar, Temperature: 94 K (-180 C).

Relevant factors of the atmosphere: - Strength of wind cca. 140km/h, - Calm belt at 80-100 km height, - At the height of 20-200-250 km brown ginger fog, - Assumed lightenings, - Assumed volcanic activity, - Assumed hydrocarbon rain/snow, - The atmosphere contains a huge Northern and Southern Hadley cell.

In case of Titan the thickness and optical features of the atmosphere do not favour observation of the surface from orbit, and the thickness of the atmosphere does not allow a low orbital height. On the basis of the Huygens findings the brown fog caused by methane or other hydrocarbons in the atmosphere limits optical perception and observation, respectively, and it allows observations in certain frequency ranges only.

To ensure the long term research and mapping of a planetary body or moon, long life functioning of the probe is necessary, which cannot be provided with traditional balloon technologies. ND technology offers long term floating, which meet these conditons.

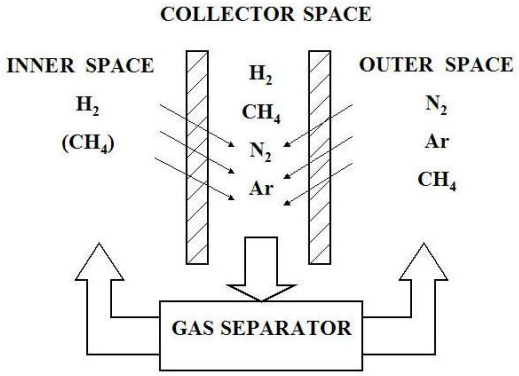

Fig. 1: *The pricniple of the Nil-Diffusion covering for lifting bodies utilized in the Titan atmosphere*

The theory of Nil-Diffusion technology: In the Nil-Diffusion (ND) covering of lifting bodies with active isolation instead of one layer, two or more layers are applied in the covering, and between the layers there is at least one collector space. The task of the collector space is to separate the material layers of the covering and it is applied as a collector. The gases penetrating through the material layers of the inner and outer layers from any direction are removed and after selection they are sent back to their source space. The separation can take place with various well-known methods depending on the different gas compositions.

Feasibility study: When applying the flying and drifting exploring airship probe made for Titan, we can exploit the fact, that according to the current research findings there is a huge Hadley-cell on both hemispheres of Titan, where there is rising motion near the equator, and horizontal poleward flow high above the surface, and descending motion at the poles. Equatorward flow near the surface closes the cell.

We assume, that with the help of the above facts, air voyages are promisful for a airship probe in the whole atmosphere, because these flows take it - drifting in the layers near the surface - towards the equator, while the rising motions near the equator and flowing back above take the probe towards the poles. Therefore it can be expected, that the circulation of the atmosphere let a drifting, controllable, positioned probe fly round and round in the atmosphere in such a way. This airship probe can investigate the whole surface of Titan within a certain time.

Using of the above facts, the commandable drifting exploring airship probe with LTA airship structure adapted to Titan conditions can be constructed. The atmosphere of Titan can be directly observed from this probe and the whole soil surface can be closely seen optically and can be mapped.

Practical applications: Units on board the probe: Energy resource: in given case a nuclear unit providing functioning for several months or a year in given case, because the solar cell doesn't give sufficient energy. Gas separator, or gas managing unit: for functioning ND technology. Others: commanding unit, navigational unit, measuring instruments, communicational, data collecting and data recording devices.

Preferable embodiment: The Titan exploring airship probe is a complex LTA gas balloon strucure with complex lifting body. It consists of six hose gas balloons of cylinder shape, stiffened with over-pressure, in which the cylinders joining each other, and this way they forms a lengthwise axial circulation channel (JET) in the middle. The rate of length/diameter of the joined lengthwise hose modules is miniumum 10/1. In the middle air-channel there is a rotor for driving and positioning. Near the bow, outside the airship probe there is a ringed wheel (Fig. 2).

The filling gas is preferably hydrogen, which ensures the relative greatest lifting force and requieres the smallest balloon size. The neutral gas applied in the collectos space is methane, which is at the same time a component of the outer atmosphere to a small degree.

The on-board units of the airship probe are fixed to the bottom of the lifting body as a payload, so the center of gravity of the system is placed low. This helps vertical positioning with the help of gravity, respectively helps keeping the direction.

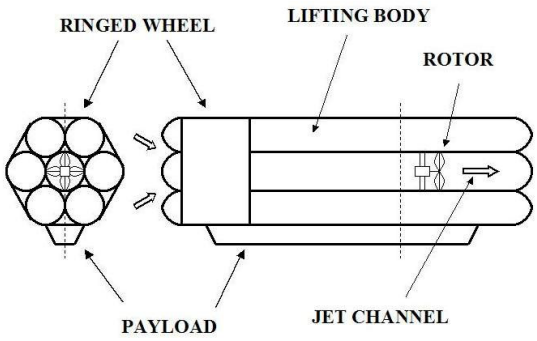

Fig. 2: *Nil-Diffusion LTA exploring airship probe for the conditions of Titan atmosphere*

The whole airship unit has a so called ringed wheel enclosing the cylinders from outside. It is such a belt, which encloses the cylinders in such a way, that the air can circulate between the belt and the cylinder as well. This structure always sets the lengthwise axle of the airship probe unit to the direction of wind. The rotor, located in the middle air channel also serves positioning and manoeuvering ability, and also contributes to positioning the lengthwise axle of the airship unit towards the direction of wind with a slight suction. So a multiple-stabilized unit positioned towards the wind, drifting together with the wind is created.

The airship probe moving together with the atmospheric circulation is a stable unit, which is especially suitable for observation and transmitting data. After potential atmospheric turbulences the unit can adjust itself to a stable state which is maintained until the atmospheric conditions, the direction of the circulation, the height is unchanged. The rotor is also suitable to a certain extent to drive and manoeuvre the airship probe.

The probe unit has a pneumatic frame, which can inflate itself, which can be launched either from the orbiter unit, or from the landing unit. The tube-like lifting containers joined together form a stable, self-supporting structure, which can endure entering the atmosphere in case of launching from the orbiter. The material of the lifting hoses is of minimum two-ply polyvinilalcohol or teflon with great cold resistance.

Advantages: The probe is suitable for the local examination of the atmosphere, e.g. circulation, temperature, pressure, composition of gas, micro-dust, electrical charge, etc. It is able to rove, map, and photograph the whole surface of Titan driven by the high and near surface layer-winds.

References: [1] I. Nehéz et. al.: Theoretical questions of the application of the light and long life gas balloons in Martian and planetary atmospheres. 37th LPSC 2006 #1703, [2] Coustenis, A. Titan's atmospheric composition: from Voyager to Cassini and beyond. American Geophysical Union Fall Meeting 2007, #P21D-01