Science on Stage Festival, 17-20 June 2015, London

From an ionic hair dryer to a satellite with ion engine
Country Germany, DE7
Name Holger Bach
Organisation Hoelty-Gymnasium Celle
A series of demonstrations looking at negative ions, ion wind, and repulsion of ion power.

<table>
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<th>Project description for the national event 7 – 8 November 2014 in Berlin for participation in the European Science on Stage festival 2015 in London</th>
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<td>Please fill in the grey-marked fields and send it back by 30 September 2014 to <a href="mailto:info@science-on-stage.de">info@science-on-stage.de</a>. Additional material can be sent separately as attachment.</td>
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<tr>
<td>Please note that you agree with this document that your project description will be published in the conference material and on the Science on Stage webpage. Your e-mail address will be given only to the participants. Personal contact details will not be given to third parties.</td>
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Main contact person

**Title** (Dr, Prof, etc.):

First Name: Holger

Surname: Bach

**School / institution:** Hoelty-Gymnasium  
**Your Subjects:** Physics

**Town:** Celle

**Country:** Germany

Names of further persons that present the project with you: -

Have you participated in a Science on Stage festival before?  
☑ Yes ☐ No

How many years of teaching experience do you have? 36

How did you get to know about Science on Stage?  
☑ Direct mailing from National Steering Committee
☐ Other Science on Stage events ☐ Social Media ☐ Colleagues
☐ Internet (webpage: ) ☐ Announcement in magazine (name: )
☐ Other channels:

Guiding Theme:  
*(Drop-down list opens by clicking.)*
Category: Please, allocate a category for your project.

☑ Fair

The Fair is the main element. Here projects are being exhibited at stands. Additionally you can apply to present your project in form of a:

☐ Workshop ☐ On-Stage activity ☐ Seminar

If On-Stage: lecture
Or: performance
Remark: The selection of the participants in the categories Workshop, On-Stage activity and Seminar will be made by the international festival committee.

Project title (short!): From an ionic hair dryer to a satellite with ion engine

Abstract: (max. 700 characters incl. spaces):
It will be demonstrated that an ion hair dryer produces negative ions by which glow lamps can be made to flash and which charge up a conductor ball to 4 – 7 kV. With the help of an ion generator from a foehn it is possible to generate ion wind, which can be made visible with joss sticks. The principle of repulsion of ion power will be demonstrated with the help of an ion lifter. The orbit of a satellite will be simulated by using system dynamics software. The one who switches the power on at the right moment of the flight can spiral himself up to the moon with his limited power supply. Manual skills are just as necessary with this project as a great intellectual ability.

Involved disciplines: Physics

Keywords: Physics, ion wind, ion generator, ionic hair dryer, ion lifter, ion power, system dynamics software, space flight

Age group (Age of the students): 14-18

Materials used in this project: Ionic hair dryer, glow lamp, electroscope, high-voltage source and high-voltage voltmeter, ion generator from a foehn as a generator of ion wind, self-built ion lifter, satellite orbit by system dynamics software.

What is innovative about your project?
By working experimentally a wide range of physical-technical properties from an everyday gadget (ion foehn) to a satellite with ion engine is covered. The co-operation of students of the 3rd and 4th year is necessary for doing this.

What can other teachers implement from your project in their class?
Starting from an everyday gadget (foehn) it is quite exciting to penetrate into the depths of physics and outer space and to take so many students of different years with you.

Personal quotation concerning your project: If you don’t try out you will never find out.

Project description: (max. 12,000 characters incl. spaces / approx. 2.5 pages)
Our school among 25 other schools qualified with our project for the “IdeenExpo” in 2013. The “IdeenExpo” is an event for young people interested in the areas of natural sciences and technology. It is based on active participation and practical experience. The “IdeenExpo” takes place at the exhibition centre in Hanover every two years. It is called the “biggest classroom of the world”. All in all there were more than 500 exhibition stands from different companies and universities. About 342 thousand people visited the nine-day long Hanoverian fair.

Our project is divided into two parts:
Part 1: Students of the years 8-9 examine the physical-technical features of an ion foehn, which is in the meantime in use in many bathrooms. They use the foehn for various experiments with ions, dismantle an ion foehn and use the ion generator inside for the generating of ion wind. Apart from
that they build a spectacular ion lifter with which the principle of repulsion can be demonstrated and which makes the ion wind perceptible on the palm of one’s hand. The ion lifter is the connection link to the second part.

Part 2: Students of the years 10 – 12 explain the ion power of satellites and simulate the orbit of a satellite on its way to the moon with the aid of system dynamics software. The data of the first satellite of the ESA driven by ion power – SMART -1 – are taken as a basis.

The two parts will be dealt with separately in the lessons. They can also be presented individually, but it is particularly attractive if the complete project is presented at school as the result of the lessons of different years.

In detail there are the following experiments. Almost all of them can be carried out by the visitors during the presentation.

1. A common foehn or an ion foehn is directed at a conductor ball on an insulating stem. After a short time a glow lamp is held against the ball. Observation: Only if the ion foehn is directed towards the ball, the glow lamp will flash when discharging. It flashes at the side which is directed towards the ball. Explanation: The air coming from the ion foehn contains electrical charges. They are negative charges.

2. An electroscope with a conductor ball is charged negatively or positively by a high-voltage source. Then the ion foehn is directed towards a Farady pail. Observation: The charge of the electroscope only gets weaker, if the electroscope has been charged positively beforehand. Explanation: Charges of the same denomination repel each other, opposite charges attract and neutralize each other.

3. An ion foehn blows into a Farady pail which is fixed on an electroscope. An electrostatic voltmeter is connected to the electroscope. A glow lamp is held against the outside of the cup. Observation: The electroscope swings, a voltage of 3000 to 4000 volt is indicated. The glow lamp flashes, the indicator of the electroscope falls back. Explanation see above. The high voltage in the kV area is surprising. It does not produce even the beginnings of an electrical shock because of its low energy, which is released when being discharged.

4. A dismantled common foehn and a dismantled ion foehn are displayed. The electrical functioning and the effects on the hair are explained at the stand.

5. The removed ion generator is placed 10 cm in front of a wire spiral which is connected to the positive pole of a high-voltage source. The ions produced move towards the wire spiral and sweep along in the air. The ion wind is made visible with joss sticks.

6. The ion lifter is connected to the high voltage source and starts to float. Someone puts his hand under the ion lifter and feels some draught that can also be made visible with the help of a joss stick.

7. A model of SMART – 1 will be built that has half the size of the original. The model satellite is impressive 7 m long and also serves as an eye-catcher. It makes the dimensions of space missions clear. SMART – 1 weighed 370 kg; 82 kg of its weight was fuel (Xenon).

8. The orbit of a satellite with ion engine can be simulated by system dynamics software. The ion power plant can be switched on or off at any time of the flight. Almost all parameters of satellite SMART – 1 will be applied in the model. Only a few parameters will be adapted in the way that the flying time will only stay within a range of minutes and the elliptical paths remain distinguishable. It is also taken into account in the model that the total weight of the satellite is decreasing because of the consumption of fuel. There are various opportunities for information: the speedometer, indicators of the distances between earth and moon, the end of the simulation, when the fuel has been used. There will be astonishment concerning the low thrust of an ion power plant. It is as big
as the weight power of a one-euro coin. The changes of the path, which are caused by the power plant switched on, are at once been made visible in real time during the simulation. What is quite decisive: The fuel for a flight up to the moon will only be sufficient if the drive is ignited in those areas of the orbit that are near to the earth.

References/Sources:

1. About the ion lifter:

Abstract:
The lifter presented in this article is a fascinating flying object that can be made floating without any movable elements but only through the use of ion power. Although or perhaps just because of the fact that the lifter can be constructed from such simple materials like wire, straws and tin foil it attracts much attention and arouses much astonishment and questioning faces.

Below a construction manual of a lifter and a simple theory about the way it is functioning will be presented. The theoretical results are completed by various proposals for experiments and supported by corresponding results of measurements

Impressive videos about lifters can be seen at Youtube. Additional information about the construction of ion lifters can be found at www.holgerbach.gmxhome.de

2. About the ion power and the orbit of SMART-1:

3. Powersim was used as software for creating models. It is possible to download a three-month full version by using a special code (free from Powersim). Other software for creating models can be used likewise. The programme code worked out with students can be found at www.holgerbach.gmxhome.de
An introduction to software for creating models and to the development of the actual programme codes can be easily derived from the programme code. It is quite impressive that one basically only needs the basic equations of mechanics, the law of gravity and the centripetal force.

Eight double periods should be allowed for the introduction in the software for creating models and the simulation of the satellite orbit.

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Pictures: Please send pictures and graphics in a separate attachment in an e-mail to info@science-on-stage.de. Make sure that you have the reproduction rights for the pictures. The resolution needs to be min. 300 dpi.
Thank you very much!
Creativity in science education

From an ionic hair dryer to a satellite with ion engine

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