Workshops at the Royal Institution August 2025

Our seventh Skateboards to Starships workshop

John I Davies

i4is has been delivering workshops for school students Skateboards to Starships since 2018.

This year we were invited back for both the Easter break and the August holiday.

In August we had two groups -

1. Skateboards to Starships (age 13-15)
2. Skateboards to Starships (age 16-18)

Rob Swinney and John Davies delivered the talks. This time they were ably assisted by three volunteers from KCL Space, the student space society at Kings College London - Sophia Li, Chinbold Odon and Keanu Utomo.

It was great to be back at the RI again. As always the staff were very helpful and our thanks go to Lisa Derry for organising things at the RI and Richard Marshall who was both the RI organiser in place and invaluable helping the students in the exercises we ran and with the analysis after each of them.
Richard is also the producer of Science in the Pub (https://pubsci.info/ and https://linktr.ee/thatscienceguy).

The agenda for both days of the workshop

The work for each of the two days was based on our events in earlier years. For example -

QUESTION

What we are asking you to calculate: What percentage of orbital velocity can you achieve with different amounts of fuel and estimate (or calculate) what fuel required for 100% 'orbital velocity'.

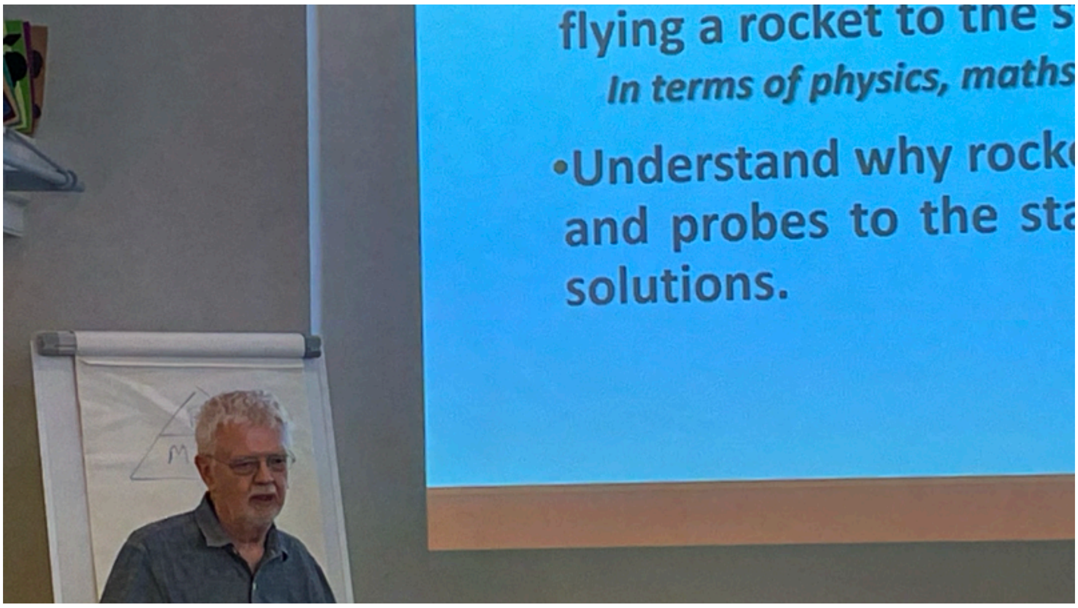
Low earth orbit needs a velocity of about 8 km/sec. Think of your tiny capsule, the rocket payload, as 1,000 kg – with only you in it! And let's assume your rocket body and engine mass will be about 5% of your fuel mass. Using liquid oxygen and liquid hydrogen fuel gives your rocket an exhaust velocity of 5,700 m/sec, then what will be the total mass of your fuelled rocket and capsule to get to orbit? (Rocket engineers call this total mass the 'wet mass' and includes the fuel.) Then work through the table.

Tsiolkovsky equation: $\Delta V = V_e \ln(M_o/M_f)$

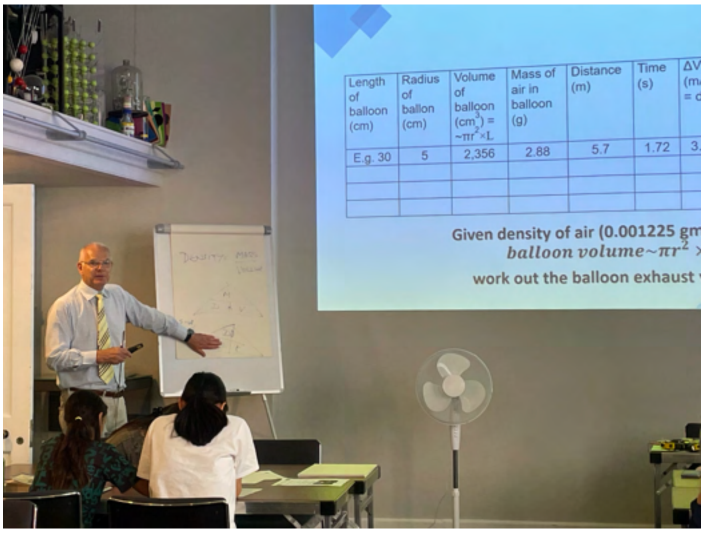
For the rest of the calculation the other practicals we use see *Royal Institution April 2024 – Our fifth Skateboards to Starships workshop* in Principium 45 May 2024 (https://i4is.org/principium-45/).
The most fun one was, as always, the balloon exhaust velocity experiment - using balloons attached to a wire as the propulsion units, record the distance travelled and the time taken, use the speed, distance & time equation you calculate the average velocity to give you the ~ΔV and transpose the Tsiolkovsky equation to work out the exhaust velocity of balloon rockets.

The workshops in pictures

Here are some images from the event - note safeguarding guidelines mean you don't see the faces of younger students. All are courtesy of one of our KCL Space volunteers, Sophia Li, with the exception of the 13-15 teams' calculations, credit Rob Swinney.

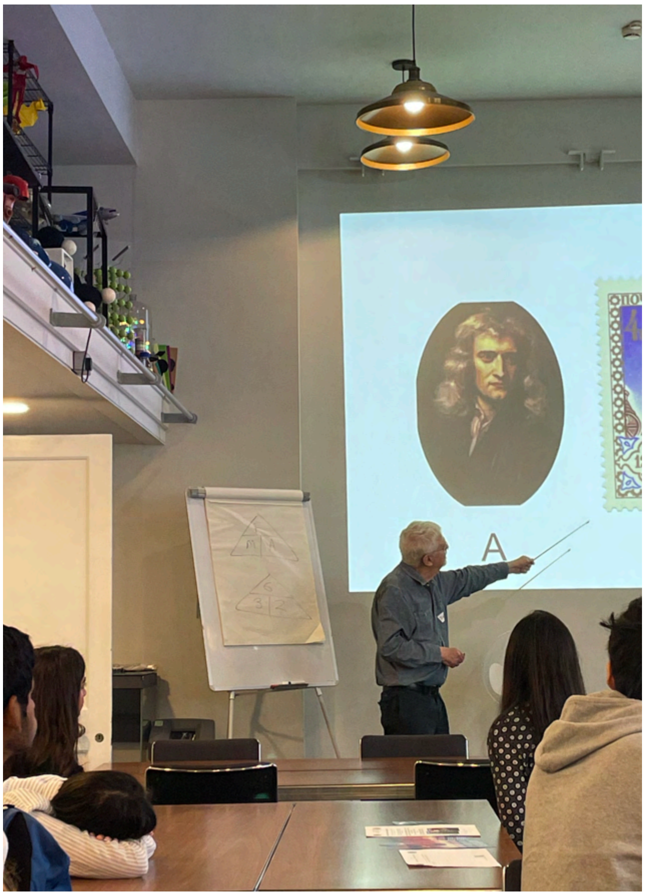


John explains the objectives of the workshop.

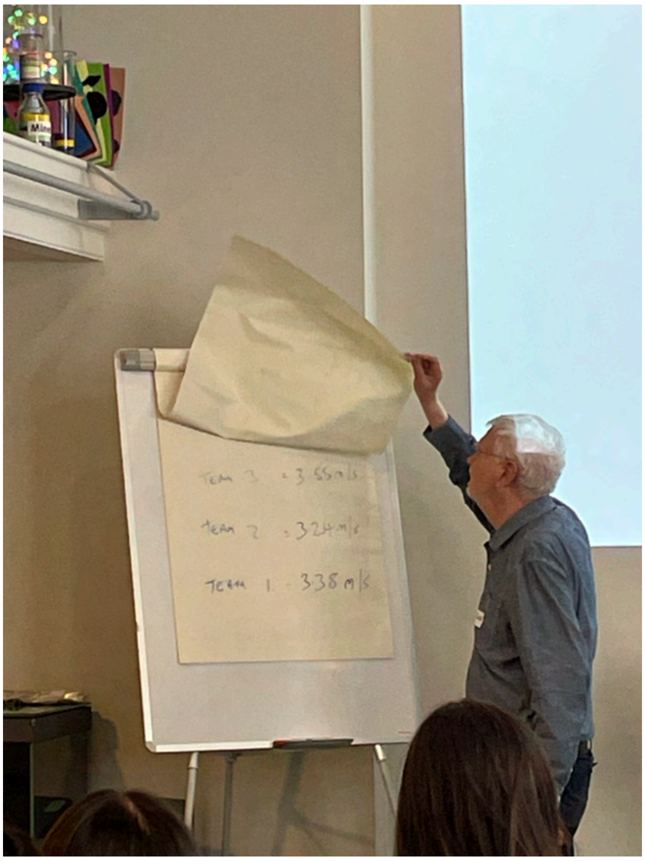


Rob explains how to calculate the balloon exhaust velocity (above).

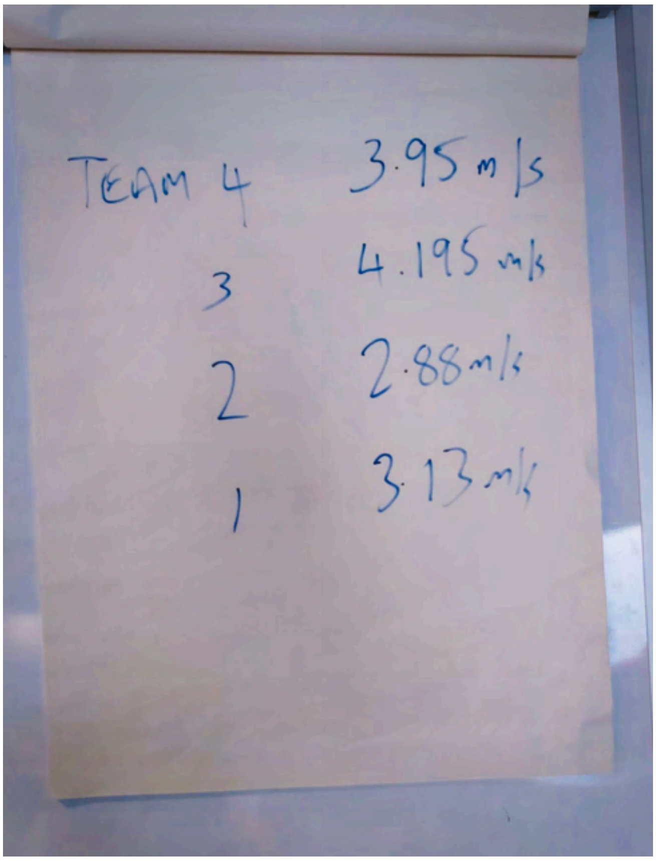
John explains how Newton's second law and Al-Karismi's algebra provide the foundation of Tsiolkovsky's Rocket Equation (right).



Rob helps some of the students with the balloon rocket calculation. Others are already deep in solving it.

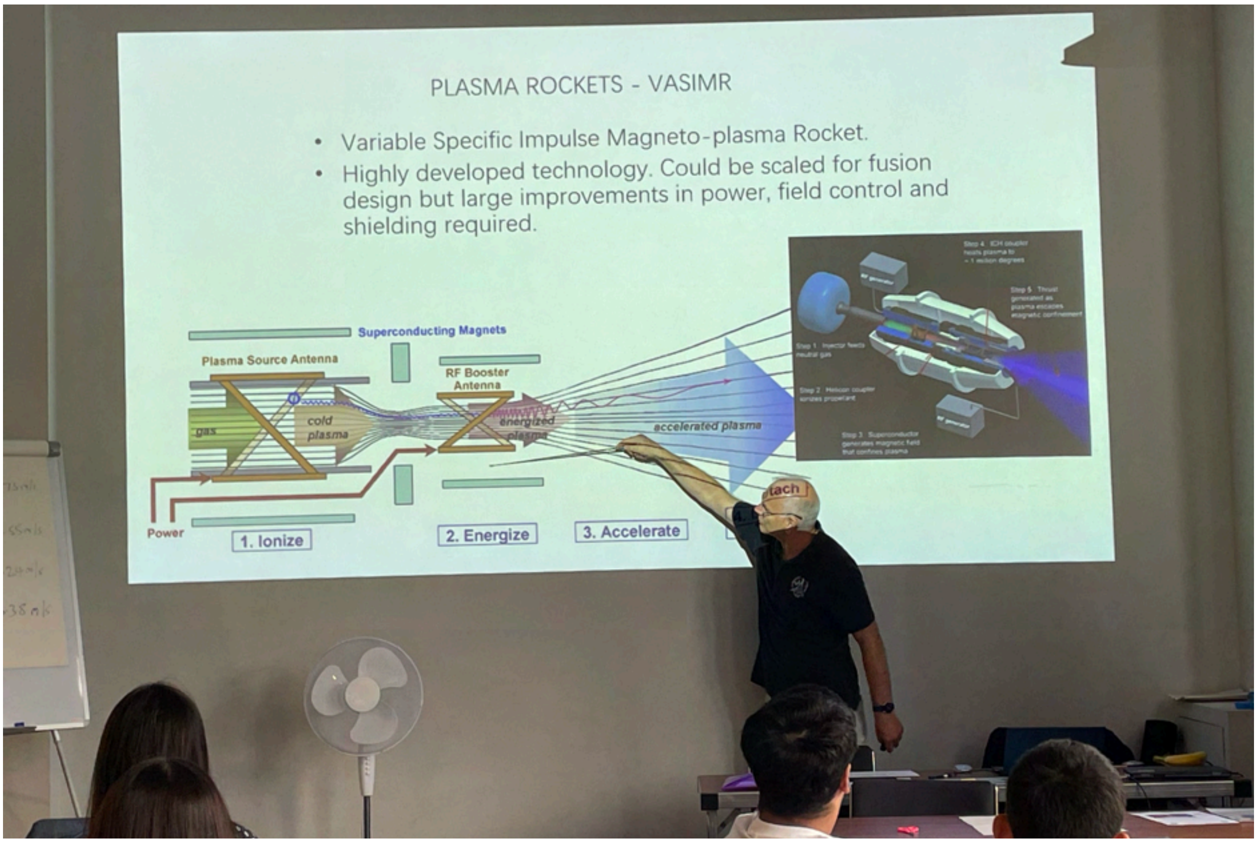


John unveils the balloon exhaust velocities calculated by the three age 16-18 teams. Given the necessarily approximate measured parameters the results are in fairly close agreement.



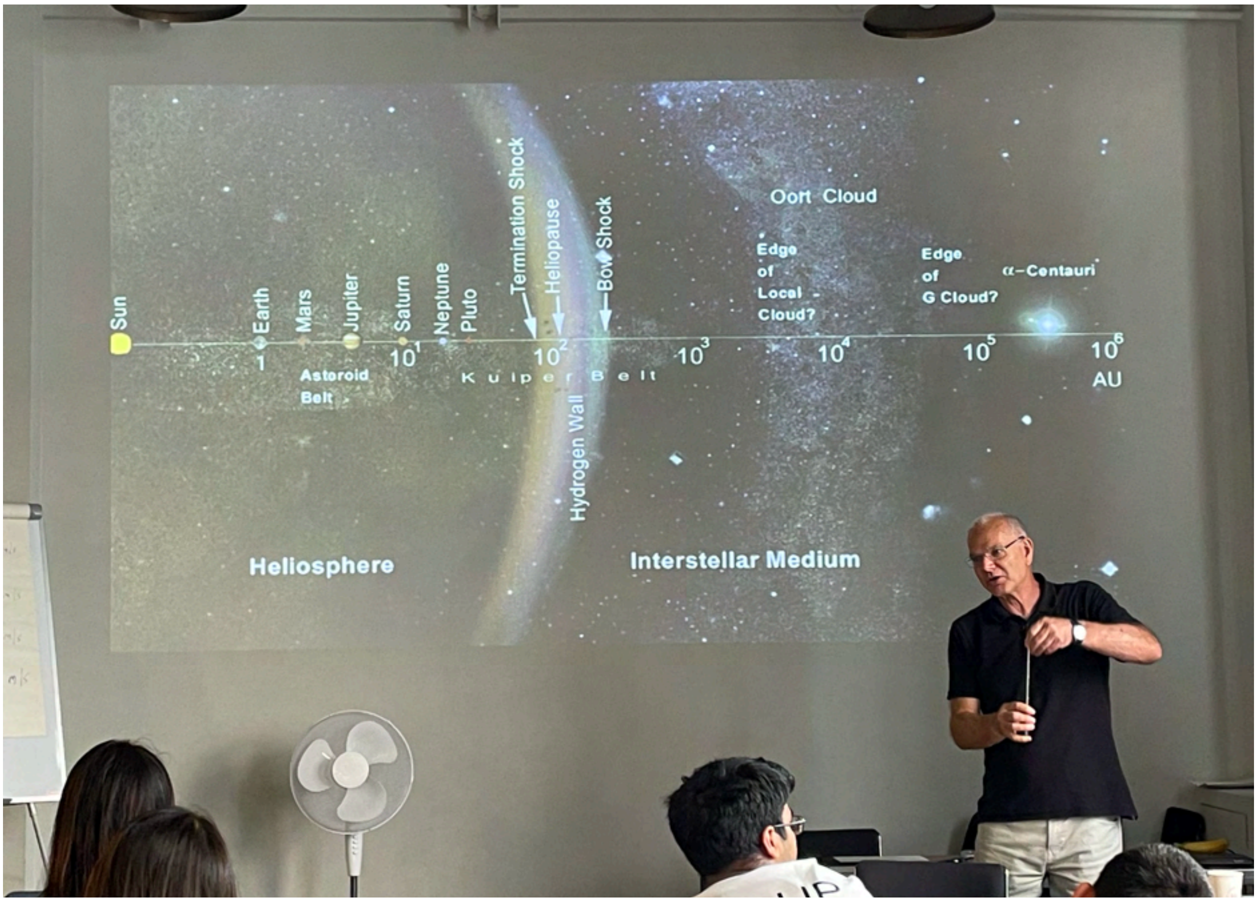
Team 1 3.13 metres per second
Team 2 2.88 metres per second
Team 3 4.195 metres per second
Team 4 3.95 metres per second
The age 13-15 teams were further apart in their calculations.

A video of the latest SpaceX Starship launch. Rob discusses overcoming the first big obstacle to our future in space – access to low Earth orbit (LEO).

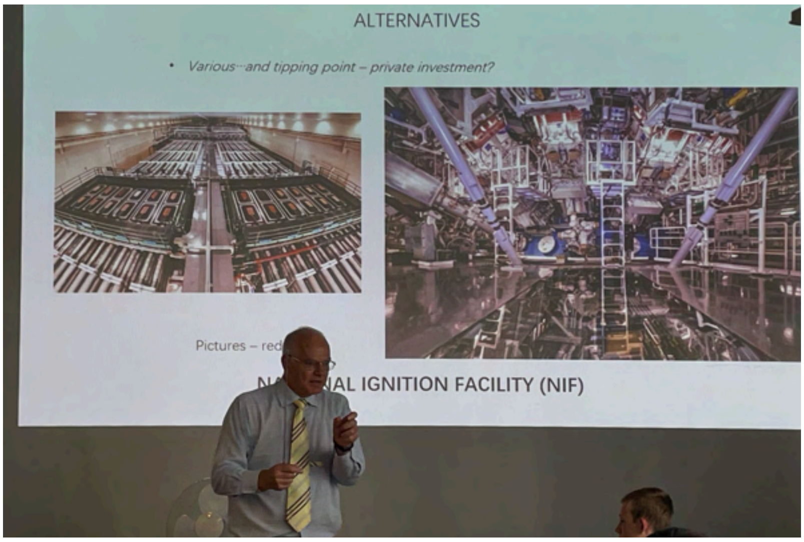


Variable Specific Impulse Magneto-plasma (VASIMR) rocket propulsion.
Rob demonstrates a near term advance in efficient rocket propulsion.

Rob and John in action.
We all need hands to make our points!



Rob illustrates the scale of the problem using a logarithmic diagram of planetary and stellar distances created by the Johns Hopkins University Applied Physics laboratory. "You may think it's a long way down the road to the Post Office but that's peanuts to space" as Douglas Adams remarked.



Laser fusion at the Stanford National Ignition Facility. Rob discusses how a similar process could lead to fusion propulsion taking large spacecraft to the nearest stars in decades.