2015 AIAA Aviation Conference

Next week, we'll be presenting at the AIAA Aviation conference (one of the two largest conferences in aerospace sciences) a new approach in simulating plasma aerodynamics.

Plasma aerodynamics, or plasma flow control, has been shown through various experiments to be viable in improving the performance of aircraft either by increasing the maximum angle of attack of airfoils, by preventing shock-induced boundary layer separation, or by generating power onboard through an MHD generator. However, numerical simulations mirroring the experimental results have remained scarce so far.

The reason plasma aerodynamics has been especially difficult to simulate numerically is due to the electron and ion transport equations being too stiff to be solved in coupled form with the neutrals. Such high stiffness was attributed to the high discrepancy between the various physical time scales involved: while electrons travel at millions of meters per second in the cathode sheaths (near the electrodes), ions and neutrals travel at velocities typically 3-5 orders of magnitude less. Thus, it was not possible to integrate the electron transport equation in coupled form with the other equations and this lead to major computational difficulties.

In this paper, we propose a solution to this problem. We get rid of the stiffness of the electron and ion transport equations through a recast and show that they can then be integrated in coupled form with the neutrals. This leads to a hundredfold reduction in computational effort. Some relevant test cases show that, when using the proposed recast equations for the electrons and ions, plasma aerodynamics flowfields can be integrated in more or less the same number of iterations as conventional non-ionized aerodynamics.

You can read more about it in the slides and the paper attached which will be presented at the upcoming conference.

article.pdf slides.pdf