

# Traveling Plasma Wave Levitation of Objects Supported By Coanda Effect

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## Abstract

The idea on this subject was born during examination of plasma waves for surface sterilization purpose. Electrostatically excited plasma waves can induce a "plasma wind" in the surrounding media or air. See flow (Figure 1) and electric field scheme of the travelling wave (Figure 2). The lifted object has a shape of a flying saucer, just for better illustration. A travelling plasma wave propulsion requires a pre-ionized media around the surface and a traveling electrostatic field. The pre-ionization can be induced by DBD (dielectric barrier discharge) or by discharge electrode wire, for instance. There are also some other interesting recent developments, studies and prototypes with this technology, see references.

A simplified plasma model was used to set up an EFD (electro fluid dynamic) approach into a COMSOL Multiphysics® model. The pre-ionization of air and force on fluid was covered by just coupling the electric field [V/m] as a volume force (drag or lift) to the fluid dynamics equations, here laminar flow Navier-Stokes equations. Further studies will include a more enhanced approach to pre-ionization of media.

Respecting the simplicity of this modeling, the results were impressive and show new scope of how to move or levitate objects in a silent and clean way without any moving parts. The travelling plasma wave in the media is shown as electric potential (Figure 3). The electric field on the object's surface is displayed in (Figure 4). Support of the Coanda effect is clearly visible in (Figure 1), where no flow detachment can be observed on the object. The plasma wave induces and stabilizes the boundary layer flow, so it can become propulsive.

As shown above, this simple approach can help understanding "plasma wave manipulation of boundary layers" on aircraft, plasma wave driven air flow and particle separation without filters in clean rooms, and development of extraordinary flying or levitated vehicles.

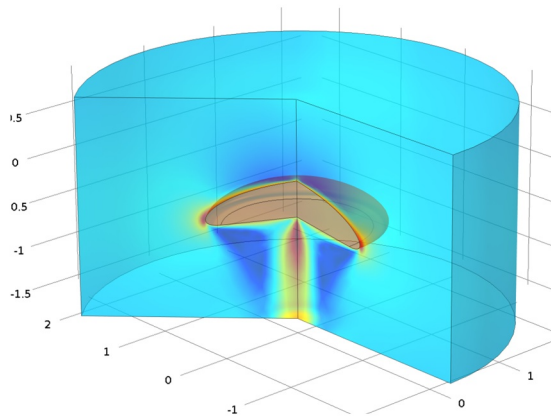
## Reference

1) B. Göksel et al., Pulsed Plasma Actuators for Active Flow Control at MAV Reynolds Numbers, Notes on Numerical Fluid Mechanics and Multidisciplinary Design (NNFM) Volume 95, 2007, pp 42-55, Springer

2) b-IONIC Airfish, Festo AG & Co. KG, Germany, company's image flyer ([http://www.festo.com/rep/zh\\_corp/assets/pdf/b\\_IONIC\\_Airfish\\_de.pdf](http://www.festo.com/rep/zh_corp/assets/pdf/b_IONIC_Airfish_de.pdf))

3) N. Benard, E. Moreau, "On the Vortex Dynamic of Airflow Reattachment Forced by a Single Non-thermal Plasma Discharge Actuator", Flow Turbulence Combust (2011) 87:1–31, Springer

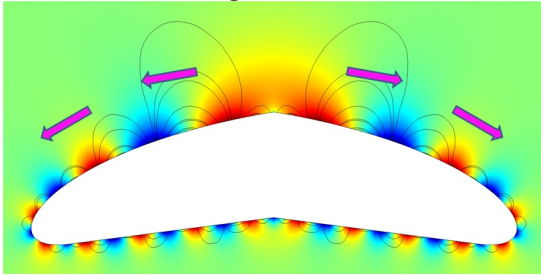
## Figures used in the abstract



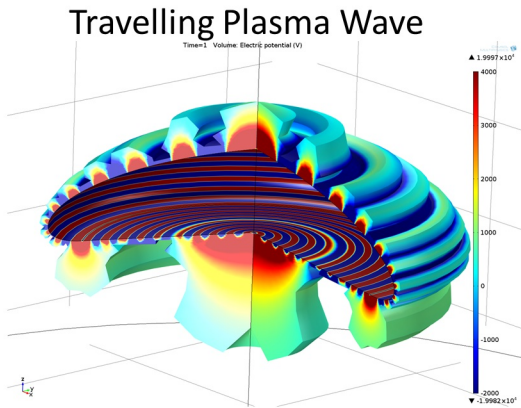
**Figure 1:** Lifting Body.

## Coanda Lift

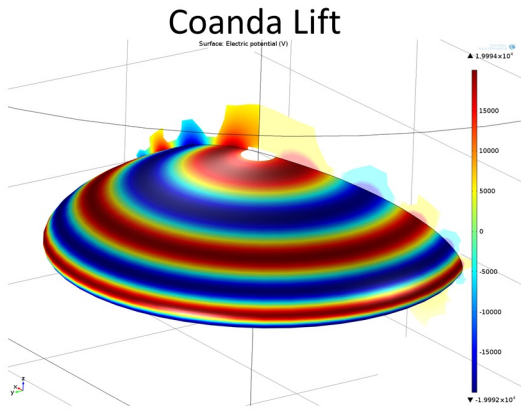
Travelling Plasma Wave



**Figure 2:** Traveling Plasma Wave - Scheme.



**Figure 3:** Traveling Plasma Wave 3D.



**Figure 4:** Plasma Wave Electric Field on Surface.