An Ionic Wind-Based Propulsion System for Space Transport

Peter A. Johnson, B.Sc. (Hons); John C. Johnson, B.Sc. (Hons); Riley Witiw, B.A.; and Austin A. Mardon, Ph.D., C.M.

Antarctic Institute of Canada, Edmonton AB, Canada.
University of Alberta, Edmonton AB, Canada.

E-mail: paj1@ualberta.ca*
jcj2@ualberta.ca
aamardon@yahoo.ca

ABSTRACT

The use of ionic wind propulsion for aircraft has been discussed in the literature. Here the authors discuss ionic wind propulsion as a transport possibility in space which is conceivable although, presently theoretical. With the current advancements in technology, such a propulsion system not only seems much more feasible outside of Earth, it also offers a promising means of transport in the future for human exploration and habitation on the moon or within the inner-planets.

(Keywords: ionic wind propulsion, aircraft propulsion, interplanetary exploration, transport)

INTRODUCTION

Ionic winds are an electrohydrodynamic phenomenon which is a form of air movement resulting from the collision of neutral and charged molecules subjected to an electric field. The possibility that they can be harnessed for the propulsion of aircrafts has been widely explored, however the feasibility remained untested and unclear.

Recently, Xu, *et al.* provided a proof-of-concept prototype for ionic wind propulsion overcoming limitations which were believed to make ionic wind-driven propulsion unviable. We propose ionic wind propulsion as an achievable means of propulsion for aircraft in the lunar and extra-celestial atmosphere. Not only would this prevent the use of fossil fuel combustion and moving parts for aircraft, it would offer a more economical and efficient mode of transportation during space exploration on the moon and other planets.

Benefits

The use of ionic wind propulsion on Earth for transport has several benefits and may in fact be more feasible as transport on Earth. One critical limitation is resource consumption. Based on the optimization algorithm, a feasible design for the aircraft for features limit features such as weight, wingspan, electrical power requirements, and velocity.

The prototype developed by Xu, *et al.* used a wingspan of 5 meters, had a mass of 2.5 kilograms, flight velocity of 4.8 meters per second and a power requirement of 600 watts. On the moon and other interplanetary bodies, a more economical requirement can be anticipated as there is an inherent lower gravitational pull and vastly thin, low-density atmosphere. It can thus be hypothesized that a greater mass, smaller wingspan and greater velocity for propulsion can be generated with the same amount of power. Moreover, such an aircraft would be limited to the lunar or planetary atmosphere and insufficient to reach orbit.

Another challenge for ionic wind propulsion to be maintained is generating sufficient thrust while ensuring low aircraft drag and weight. This means overcoming the thrust-to-power ratio and thrust density, which has been deemed unrealistic until recently.

In spite of the proof-of-concept demonstrating this could be achieved, the overall efficiency of such a propulsion system is poor. There exists a threshold thrust-to-power ratio and thrust density using corona discharge and the tradeoff between the two variables result in inequality constraints and a lower efficiency.

As such, the reliability of this propulsion system is also limited to the laboratory setting. On Earth, this aircraft remains an ineffectual for transport as factors such as turbulence and payload capacity can disrupt the design optimization. In space, this issue may be attenuated in certain moons or planets as a result of differential climates and variations in gravitational forces.

Future Avenues

The next step would be to perform an optimization analysis for aircraft design accounting for gravitational pull, atmospheric density, turbulence and other variables differing from Earth on the moon and other planets. As this concept remains untested, further testing in the laboratory would be recommended prior to testing in space.

Limitations

While an ionic wind propulsion system appears to be a feasible alternative to aircrafts fuelled by combustion on the moon. This theory remains untested and is based on the assumption that the lunar or planetary atmosphere is able to support such a system. There is no knowledge about the range for flight or its feasibility on the surface of different celestial bodies.

CONCLUSION

The use of ionic wind propulsion for aircraft transport in space is conceivable although it is presently theoretical. With the current advancements in technology, such a propulsion system not only seems much more feasible outside of Earth, it also offers a promising means of transport in the future for humans habitation on the moon or other planets.

REFERENCES

1. Xu, H. et al. 2018. *Nature*. 563, 532–535.

2. Plourabue. 2018. *Nature*. 563, 476-477

ABOUT THE AUTHORS

Peter A. Johnson, is a Pediatrics Graduate Student (University of Alberta), and a child health researcher with an extensive background in physiology and infection prevention and control. He is also a trainee at the Antarctic Institute of Canada.

John C. Johnson, is a Biomedical Engineering graduate student (University of Alberta) and is a scientist, author, entrepreneur, and disability advocate. He is also a trainee at the Antarctic Institute of Canada.

Riley Witiw, is a student (University of Alberta) and a communications specialist with extensive experience as an article writer for the Antarctic Institute of Canada.

Austin Albert Mardon, Ph.D., CM, FRSC (University of Alberta), is an Adjunct Professor in the Faculty of Medicine and Dentistry at the University of Alberta, an Order of Canada member, and Fellow of the Royal Society of Canada. He is the Director of the Antarctic Institute of Canada.

SUGGESTED CITATION

Johnson, P.A., J.C. Johnson, R. Witiw, and A.A. Mardon. 2020. “An Ionic Wind-Based Propulsion System for Space Transport”. *Pacific Journal of Science and Technology*. 21(1):16-17.

Pacific Journal of Science and Technology