Origin of Electric Wind in Atmospheric-Pressure Plasma Jets

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It is essential to understand the interactions between ionized matter and neutral particles in order to discover their impact on the natural phenomena. One such phenomenon is the electric wind, which supposedly occurs because of the so-called c-n coupling, i.e. interaction between charged particles and neutral particles in systems of weakly ionized plasmas, however this mechanism remains elusive until now. We here report a direct evidence demonstrating that the electric wind is caused by an electrohydrodynamic (EHD) force generated by the charged particle drag, as a result of the momentum transfer from the electrons/ions to the neutrals. The model experiments are based on an atmospheric pressure μs-pulsed helium plasma jet. From helium gas flow trajectories observed using Schlieren photography, the electric wind speed along the jet axis is estimated. Studying the changes in the electric wind speed at different pulse parameters allows one to distinguish between the effects of streamer propagation and space charge drift causing the electric wind. In addition, the study permits to determine the role of electrons and (positive) ions in the wind generation. Our key finding is that the contribution of the moving streamer to the EHD force generation is negligible, while the EHD force is mainly caused by the residual space charges after the plasma streamer propagates and collapses. Another important finding is that electrons are also a main player as well as negative ions. This will be the first clear report of the electric wind in the atmospheric-pressure plasma jets.

[1] S. Park, U. Cvelbar, W. Choe, and S. Y. Moon, Nature Communications **9**, 371 (2018).