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Ionic propulsion with a 'crystalline plasma'

(The development of ionic propulsion methods for space vehicles was reviewed by Dr. David B. Langmuir of Ramo-Woolridge at a Colloquium on Space Exploration, March 20, 1959, California Institute of Technology. While there are many practical problems associated with low-weight generation of electric power, the ion-motor itself poses some design problems, including the production of an electrically neutral plasma. The design basis of current thinking seems to be the acceleration of Cs^+ from a heated source on which metallic cesium is impinging; this then requires the mixing in of electrons into the plasma.)

To meet the problem of neutralizing the plasma, I am suggesting the use of pairs of ions having opposite electric charge, but having the same ratio of charge: mass. These would be produced from source (e.g. a heated vapor or crystal) which would be modulated in phase with the accelerating electrodes. The RF alternating potentials of successive electrodes would then gather and accelerate successive sheets of ions of opposite charge; the plasma as a whole would be neutral. The plasma containing these sheets of ions at uniform velocity is to the extent of this ordering 'crystalline'. I do not know what the reasonable expectations are for the further interaction of these sheets, or whether they would add or detract from the efficiency of propulsion.

The periodic table gives relatively few combinations of stable isotopes having correct valency and mass. Some of the following should be considered:

$GeCl_2$	Ge^{74} Cl^{37}	SeF_4	$Se^{76}F^{19}$	NH_4F $(N^{15}H_4^1)^+$ $(F^{19})^-$
FeF_3	Fe^{57} F^{19}	$DsBr_2$	Ds^{158} Br^{79}; Ds^{162} Br^{81}	
CsI	Cs^{133} I^{127}	NaF	$Na^{23}F^{19}$	

I have not taken into account the ionization potentials of the various elements involved, nor the conditions needed to generate the respective ions: Ge^{++} ; Fe^{+++} ; Se^{++++} ; Ds^{++} ; Na^+ ; F^- , Cl^- , I^- .

The acceleration of ions of (approximately) the same mass and opposite charge into the same beam may solve the problem of neutralization, and may give some improvement in the conversion of RF energy into the beam. The ion sources might either be crystals of the compound indicated, or if this is not feasible, separately ionized sources of the two elements. Negative ions have been far less studied, and are presumably not so readily prepared as cations of, say, the alkali metals. However, studies on Br^-, I^- and F^- have been made on ions produced by electron impacts in gases.
