

Ion-neutral collision frequencies for calculating ionospheric conductivity

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Molecular oxygen collides with its first positive ion in the earth's ionosphere. The collision frequency of this particle pair is used to calculate the electric conductivity of the ionosphere. However, for this parental pair there are two collision types, resonant and nonresonant, and the selection of the collision type has differed among previous studies in calculation of conductivity.

In the present study, we clarify that the nonresonant collision is physically essential for this pair because the relevant temperatures are low. That is, the peak of the ionospheric conductivity occurs at altitudes between 100 and 130 km, where the temperatures of ions and neutral particles are usually lower than 600 K, and for these temperatures nonresonant collisions are dominant. The collision frequency would be underestimated by 30% if the resonant collision was assumed at an altitude of 110 km (where the temperature is 240 K).

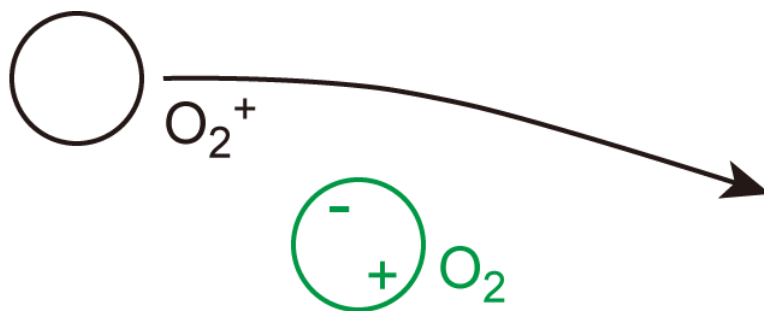
The impact of this difference on the conductivity is estimated to be small (3%), primarily because molecular nitrogen is much more abundant than molecular oxygen. Although we have confirmed that the nonresonant collision is essential, we also include the resonant type, primarily in case of possible elevated temperature events.

A set of ion-neutral collision frequency coefficients for calculating the conductivity is summarized, including other particle pairs, in the Appendices. Small corrections to the traditional coefficients are made.

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- (a)
Non-resonant type
- Polarization
 - Low particle speed



- (b)
Resonant type
- Charge-exchange
 - High particle speed

