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酸素原子のイオン-中性衝突断面積：電離圏温度での関数フィットの改良

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Improved Fit of Atomic Oxygen Ion – Neutral Collision Cross Section at Ionospheric Temperatures

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Atomic oxygen and its ion are major species in the ionospheres of Earth, Venus, and Mars. Collisions between them control the structure and dynamics of the ionosphere. An accurate collision cross-section model is thus a prerequisite for a quantitative study of the ionosphere. Fits of recent wide-energy models are reasonable for the quiet-time F-region ionosphere of Earth near 1000 K. However, their valid temperature range has been unclear and limited because of physically inaccurate fitting basis functions. We improved the classic charge-exchange fitting basis function by introducing the curved-trajectory and quantum oxygen-atom fine-structure effects. The resultant fit is accurate between 40 and 9000 K and thus can be robustly used for the ionospheres of Earth, Venus, and Mars.

Ieda (JGR, 2021), https://doi.org/10.1029/2020ja028441
Ieda (JGR, 2022), https://doi.org/10.1029/2021ja029612

酸素原子とそのイオンは、地球・金星・火星の電離圏を構成する主要な粒子種である。両粒子間の衝突は、衝突断面積モデルとして表現される。最近、教科書的な high-energy タイプのモデルでなく、wide-energy タイプのモデルが正しいことが示された (Ieda, 2021)。この wide-energy タイプのモデルの、有効な温度範囲は 300-2000 K 程度である。本研究で、カーブ軌道効果 (Ieda, 2022) を考慮することにより、関数フィットの基底関数を改良した。この結果、有効温度範囲は 75-9000 K と広がり、地球・金星・火星の電離圏に十分となった。

Ieda (JGR, 2021), https://doi.org/10.1029/2020ja028441
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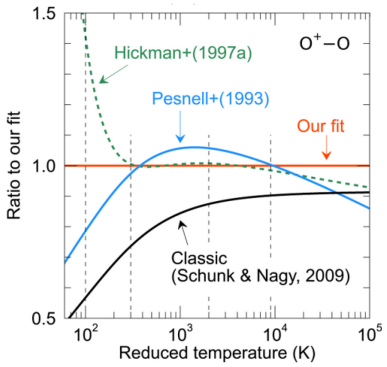

Figure 1.
O^+-O collision frequency or momentum-transfer cross section. Our concluding fit is shown by the red line. Various models are shown as the ratio to our concluding fit.

Below 300 K, only our fit is accurate because low temperatures were not concerned in previous fits. The collision frequency is underestimated in the classic model by 16% at 1000 K and by 35% at 200 K.