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RELATIVISTIC FREE-FREE GAUNT FACTORS FOR HIGH-TEMPERATURE STELLAR PLASMAS

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RESUMEN: Se calcula el factor de Gaunt para las transiciones libre-libre del plasma estelar denso y a altas temperaturas usando la sección eficaz relativística precisa, y se compara con el factor de Gaunt que se deriva de la sección exacta, no relativística, de Sommerfeld. Se toma en cuenta de forma precisa un rango amplio de la degeneración electrónica. Se encuentran desviaciones significativas para los casos a altas temperaturas.

ABSTRACT: The free-free Gaunt factor of the dense high-temperature stellar plasma is calculated by using the accurate relativistic cross section and is compared with the Gaunt factor derived by using Sommerfeld's exact nonrelativistic cross section. A wide range of electron degeneracy is accurately taken into account. Significant deviations are found for high-temperature cases.

Key words : ATOMIC PROCESSES-OPACITIES

I. INTRODUCTION

Free-free Gaunt factors are important physical quantities for the studies of stellar structure. The present author and his collaborators have recently calculated the free-free Gaunt factor of the dense high-temperature stellar plasma for the cases of hydrogen, helium, carbon, and oxygen (Itoh, Nakagawa, and Kohyama 1985; Nakagawa, Kohyama, and Itoh 1987; Itoh, Kojo, and Nakagawa 1990). Calculations were carried out for the following three cases: the relativistic Elwert calculation, the nonrelativistic exact calculation, and the nonrelativistic Elwert calculation. The following parameters are used:

$$\eta = \frac{\mu - m_e c^2}{kT} \ , \tag{1}$$

$$\gamma^2 = \frac{Z^2 R_y}{kT} = Z^2 \frac{1.579 \times 10^5 K}{T} \ , \tag{2}$$

$$u = \frac{\hbar\omega}{kT} \ , \tag{3}$$

where μ is the electron chemical potential including the rest mass, and ω is the angular frequency of the absorbed photon. The present calculation assumes a pure Coulomb field.

II. RESULTS

Examples of the results of the calculation are shown in Figures 1-4. $< g_{ff} >$ stands for the thermally averaged free-free Gaunt factor.

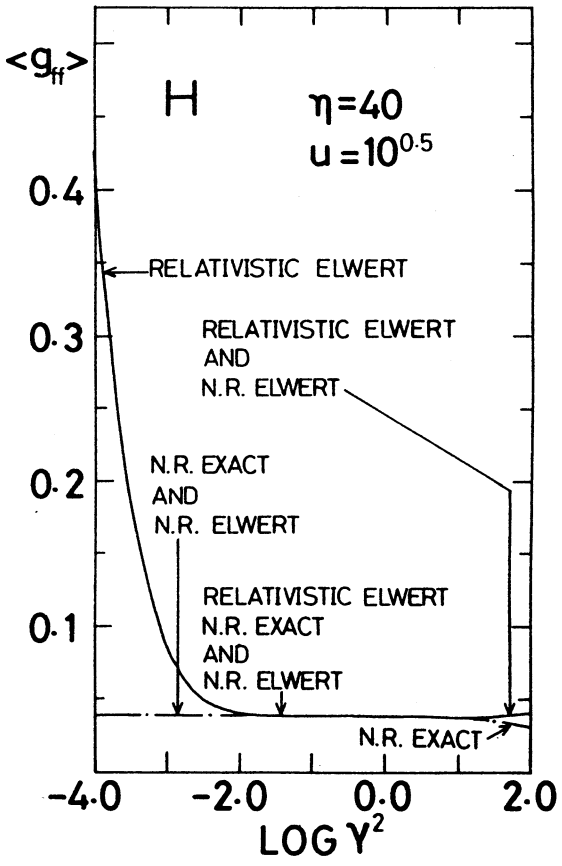

FIG.1

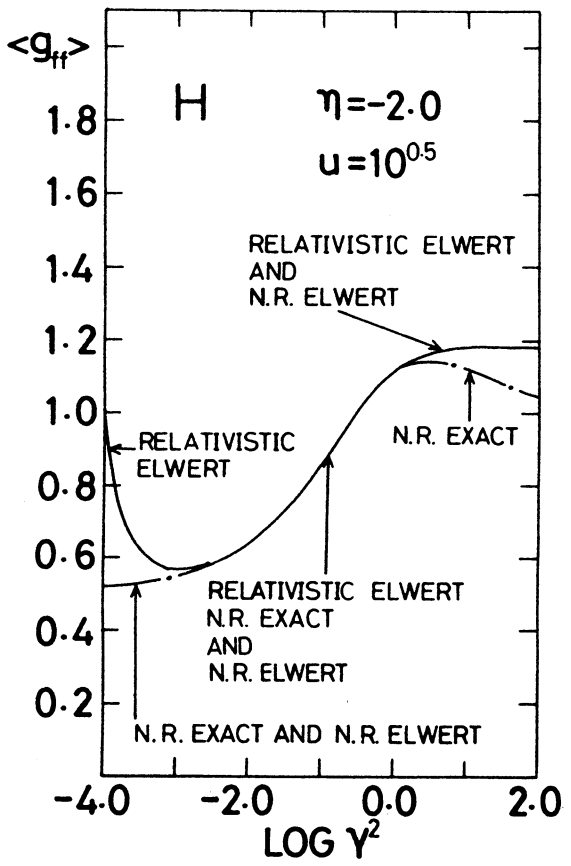

FIG.2

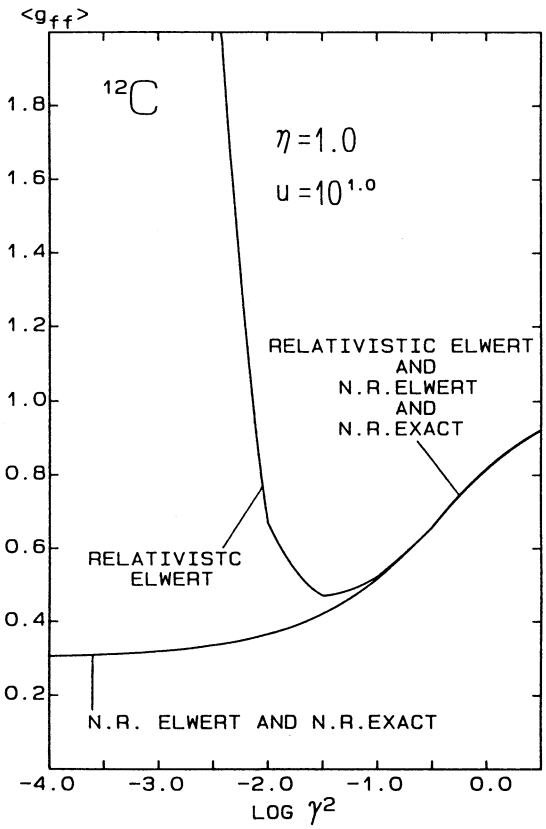

FIG.3

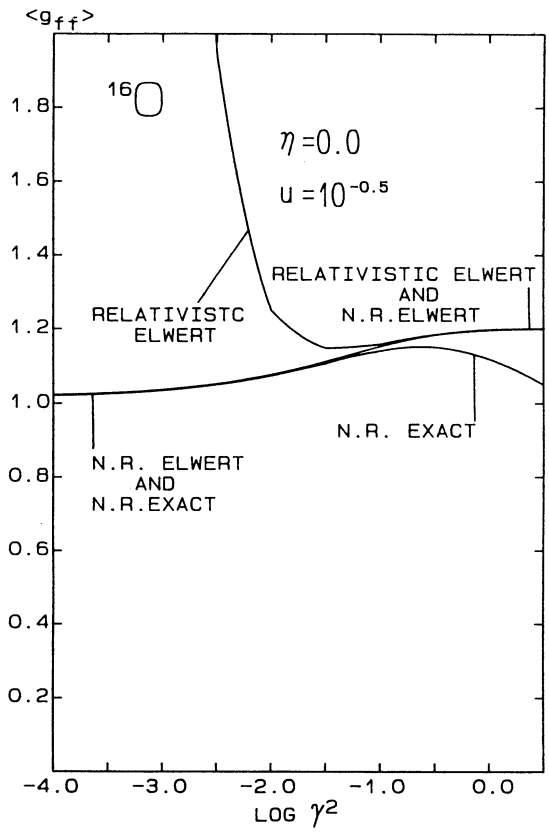

FIG.4

III. CONCLUSION

The results generally show an excellent accuracy of the Elwert approximation. However, the nonrelativistic exact results should be used at low temperatures. At high temperatures, the relativistic Elwert results should be employed. The accuracy of the present calculation is generally better than 0.2%. The present results should be also useful for testing various computation methods of the free-free Gaunt factor.

REFERENCES

Itoh, N., Kojo, K., and Nakagawa, M. 1990, Ap.J. Suppl., 74, 291.
Itoh, N., Nakagawa, M., and Kohyama, Y. 1985, Ap.J., 294, 17.
Nakagawa, M., Kohyama, Y., and Itoh, N. 1987, Ap.J. Suppl., 63, 661.

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