

CHIANTI – a widely used astrophysical plasma modeling code

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CHIANTI (<http://chiantidatabase.org>) is a critically-assessed atomic database and plasma modeling package that is widely used in astrophysics. The papers describing CHIANTI have received over 3000 citations in a 22-year period and there is a steady increase of citations per year over time (Figure 1). CHIANTI is internationally renowned, with large numbers of users across the world, and the team won the Group Achievement Award of the Royal Astronomical Society (U.K.) in 2010. The CHIANTI team has five team members, with three based in the U.S.

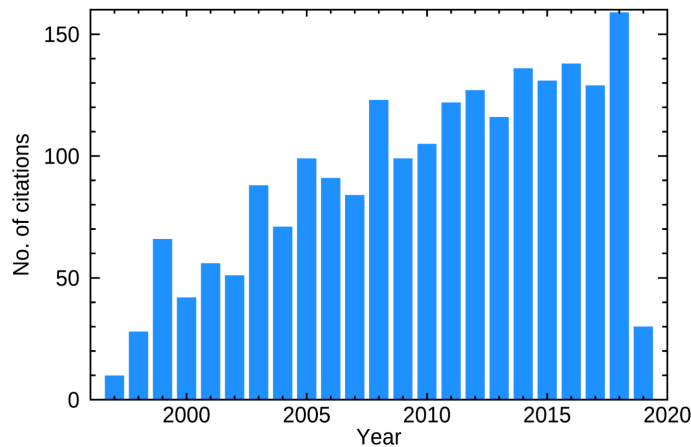


Figure 1. The numbers of citations to CHIANTI each year since release in 1997 .

CHIANTI is specifically for modeling hot ($> 10,000$ K), low density ($< 10^{13}$ particles cm^{-3}), optically thin plasmas that occur in a wide range of astrophysical objects. For example, stellar atmospheres, accretion disks, supernova remnants, nebulae and galaxy clusters. Most ionization stages of elements up to zinc are included, and the atomic database is generally useful. For example, other astrophysical plasma codes such as *Cloudy*, XSTAR, ATOMDB, and MOCASSIN directly ingest the CHIANTI data.

Users of the database include

- Spectroscopists deriving physical parameters from astrophysical spectra at energies from the infrared through to soft X-rays.
- Modelers using CHIANTI to compute synthetic spectra from 3D plasma magnetohydrodynamic codes.
- Astrophysics mission teams simulating the responses of their instruments when preparing proposals, and using CHIANTI for calibration activities after launch.

Achievements over the past decade

Key improvements in CHIANTI over the past 10 years have been

the atomic models will not be sufficiently accurate for the high-quality observations likely to be returned by future space missions (e.g., JWST). The number of scientists performing atomic calculations is declining: experienced researchers are retiring, and few young people are entering the field. The needed calculations do not represent cutting-edge quantum physics, and so **it is critical that the funding agencies who benefit from the calculations (e.g., NASA) provide sufficient funding that the field thrives.**

- The CHIANTI atomic models rely almost entirely on theoretical atomic data calculations. To assess the accuracy of the models, it is critical to benchmark against spectra of plasmas. For the most part, high-resolution spectra of astrophysical objects are used, particularly the Sun. However, these spectra often have limitations: the wide mix of elements and ionization stages often leads to blending that compromises interpretation of weak or medium-strength lines; limitations of space-based UV and X-ray instrumentation often result in compromises between spectral range and resolution, which reduces the number of useful emission lines that can be used for benchmarking activities. Laboratory UV and X-ray spectrometers were widely-used in the pioneering days of the 60's and 70's, giving wide wavelength coverage and the ability to isolate specific elements and ionization stages. These instruments have mostly been decommissioned. **The benchmarking of atomic data models would greatly benefit from new, high-resolution laboratory spectrometers in the UV and X-ray wavelength regions.**