

Redefining of Atomic Units (au), the Exact Value of Planck's Constant in au and Creation/Composition of the Universe

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Gang Chen[†], Tianman Chen, Tianyi Chen

Guangzhou HuiFu Research Institute Co., Ltd., Guangzhou, P. R. China

7-20-4, Greenwich Village, Wangjianglu 1, Chengdu, P. R. China

[†]Correspondence to: gang137.chen@connect.polyu.hk

Abstract

Hartree atomic units or atomic units (au) are defined to be $\hbar=e=a_0=m_e=1$, and is supposed to be the scientific or natural units. In this paper, we redefine the atomic units to be $\hbar_{\text{au}}=e_{\text{au}}=a_{0/\text{au}}=1$, $m_{e/\text{au}}=1+1/c_{\text{au}}^4$, $m_{e+/\text{au}}=1-1/c_{\text{au}}^4$, $\hbar_{\text{au}}=h_{\text{au}}/(2\pi)_{\text{au}}=1$ and $h_{\text{au}}=(2\pi)_{\text{au}}=6.28$, in which c_{au} is the speed of light in vacuum in atomic units and $c_{\text{au}}=137.035999074626$. The new redefined atomic units could be called Hartree-Chen atomic units and would be the real scientific or natural units especially in the sub-atomic world. In this new atomic units, the value of the Planck constant is demonstrated to be exactly 6.28. With the new atomic units, the frequencies of the original light and the subsequent light of the universe are calculated and hence a picture of creation and composition of the universe is depicted.

Keywords: atomic units, the Planck constant, the mass of electron, the mass of positron, the creation of the universe, the composition of the universe.

1. Introduction

Atomic units (au) are a system of units convenient for atomic physics, electromagnetism, and quantum electrodynamics, especially when the focus is on the properties of electrons [1]. There are two different kinds of atomic units, which one might name Hartree atomic units and Rydberg atomic units, which differ in the choice of the unit of mass and charge. This article deals with Hartree atomic units. In au, the numerical values of the following six physical constants are all unity (1) by definition:

Two properties of the electron, its mass and charge;

Two properties of the hydrogen atom, its Bohr radius and the absolute value of its electric potential energy in the ground state;

Two constants, Dirac's constant (reduced Planck constant) and Coulomb's constant.

Table 1. Fundamental Atomic Units

Quantity	Name	Symbol	SI value
length	Bohr radius	a_0	$5.291\,772\,108(18)\times 10^{-11}\text{ m}$
mass	electron rest mass	m_e	$9.109\,3826(16)\times 10^{-31}\text{ kg}$
charge	elementary charge	e	$1.602\,176\,53(14)\times 10^{-19}\text{ C}$
angular momentum	reduced Planck's constant	\hbar	$1.054\,571\,68(18)\times 10^{-34}\text{ J s}$
energy	Hartree energy	E_h	$4.359\,744\,17(75)\times 10^{-18}\text{ J}$
electrostatic force	Coulomb's constant	$k_C=1/(4\pi\epsilon_0)$	$8.9875516\times 10^9\text{ C}^{-2}\text{ N m}^2$

These six quantities are not independent; to normalize all six quantities to 1, it suffices to normalize any four of them to 1. The normalizations of the Hartree energy and Coulomb's constant, for example, are only an incidental consequence of normalizing the other four quantities.

Hartree atomic units or atomic units (au):

$$\hbar_{au} = e_{au} = m_{e/au} = a_{0/au} = \frac{1}{(4\pi\epsilon_0)_{au}} = E_{h/au} = 1$$

It suffices to normalize any four of them to 1

So Hartree Atomic Units are usually expressed as:

$$\hbar_{au} = e_{au} = m_{e/au} = a_{0/au} = 1$$

$$\text{reduced Planck's constant: } \hbar_{au} = \frac{h_{au}}{2\pi} = 1$$

$$\text{Planck's constant: } h_{au} = 2\pi$$

Some other atomic units are derived from the above four fundamental atomic units as follows (**Table 2**).

Table 2. Derived Atomic Units

Quantity	Expression	au	SI value
Hartree energy	E_h	$\hbar/(m_e a_0^2)$	$4.359\,744\,722\,2071\times 10^{-18}\text{ J}$
Coulomb's constant	$k_C=1/(4\pi\epsilon_0)$	$\hbar^2/(m_e e^2 a_0)$	$8.987\,551\,7923\times 10^9\text{ Kg m}^3\text{ s}^{-4}\text{ A}^{-2}$
atime	\hbar/E_h	$t_{0/au}=1$	$2.418\,884\,326\,505(16)\times 10^{-17}\text{ s}$
velocity	$a_0 E_h/\hbar$	$v_{e/au}=1$	$2.187\,691\,2633(73)\times 10^6\text{ m s}^{-1}$

Atomic units are derived from certain fundamental properties of the physical world, and are free of anthropocentric considerations, so atomic units should almost be scientific units or natural units.

2. Redefining of Hartree Atomic Units

Based on our previous papers [2-16], we suppose that Hartree atomic units should have some drawbacks and could be redefined to a more scientific or more natural system which we would name Hartree-Chen atomic units as follows.

Hartree Atomic Units:

$$\hbar_{au} = e_{au} = a_{0/au} = m_{e/au} = 1$$

$$\hbar_{au} = \frac{h_{au}}{2\pi} = 1, \quad h_{au} = 2\pi$$

Hartree-Chen Atomic Units:

$$\hbar_{au} = e_{au} = a_{0/au} = 1$$

$$m_{e/au} = 1 + \frac{1}{c_{au}^4}, \quad m_{e^+/au} = 1 - \frac{1}{c_{au}^4}$$

$$\hbar_{au} = \frac{h_{au}}{(2\pi)_{au}} = 1, \quad h_{au} = (2\pi)_{au} = \frac{4 \times 157}{100} = 6.28$$

$$c_{au} = \frac{c}{v_e} = \sqrt{112 \times (168 - \frac{1}{3} + \frac{1}{12 \cdot 47} - \frac{1}{14 \cdot 112 \cdot (2 \cdot 173 + 1)})} = 137.035999074626$$

c : the speed of light in vacuum

v_e : the line speed of the ground state electron of H atom in Bohr model

Note: in sub-atomic world, $\sqrt{2}$, $\sqrt{3}$ and π express as rational numbers as follows [14].

$$(\sqrt{2})_{au} = \frac{3 \times 47}{100} = 1.41, \quad (\sqrt{3})_{au} = \frac{173}{100} = 1.73, \quad (\pi)_{au} = \frac{2 \times 157}{100} = 3.14$$

$$(\sqrt{2})_{au} + (\sqrt{3})_{au} = (\pi)_{au}, \quad 1.41 + 1.73 = 3.14$$

$$\left(\frac{\sqrt{2}}{2}\right)_{au} + \left(\frac{\sqrt{3}}{2}\right)_{au} = \left(\frac{\pi}{2}\right)_{au}, \quad \left(\sin \frac{\pi}{4}\right)_{au} + \left(\sin \frac{\pi}{3}\right)_{au} = \left(\frac{\pi}{2}\right)_{au}$$

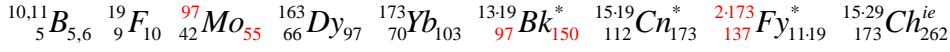
$$\text{so: } (2\pi)_{au} = \frac{4 \times 157}{100} = 6.28$$

3. The Exact Value of Plank's Constant in Hartree-Chen Atomic Units

The Planck constant or Plank's constant h has the exact value of 6.62607015 J/Hz in SI units, and the reduced Planck constant, or Dirac constant \hbar is defined to be $h/2\pi$. In Hartree atomic units (au), the reduced Planck constant \hbar_{au} is 1, so in Hartree atomic units the Planck constant h_{au} should equal to 2π ($h_{au}=2\pi$). As atomic units should be the real scientific units, so $h_{au}=2\pi$ should be reasonable in sub-atomic world. According to ordinary mathematical and physical concepts, $h_{au}=2\pi$ should be an irrational number. However, in our previous paper [14], we define the natural number axis (NNA) and the

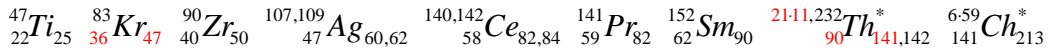
Other Explanations of $v_{0/au}$ and $v_{1/au}$:

$$v_{0/au} = \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{9 \cdot (2 \cdot 97 \cdot 173 + 1) - \frac{2 \cdot 5}{3 \cdot 7}} \right) \right]^2 = 2990.26513413709$$



$$v_{0/au} = \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{2 \cdot (90 - 1)(2 \cdot 3 \cdot (2 \cdot 3 \cdot 47 + 1) - 1) + \frac{11}{3 \cdot 7}} \right) \right]^2$$

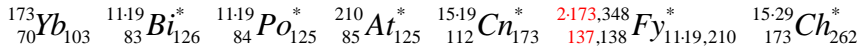
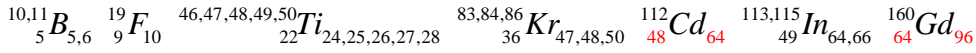
$$= 2990.26513413709$$



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$$v_{0/au} = \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{9 \cdot (2 \cdot (2 \cdot 49 - 1) \cdot 173 + 1) - \frac{2 \cdot 5}{3 \cdot 7}} \right) \right]^2$$

$$= \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{9 \cdot (2 \cdot (32 \cdot 3 + 1) \cdot 173 + 1) - \frac{2 \cdot 5}{3 \cdot 7}} \right) \right]^2 = 2990.26513413709$$



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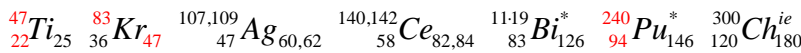
$$v_{1/au} = \frac{m_{e^+/au} c_{au}^2}{h_{au}} = \frac{\left(1 - \frac{1}{4}\right) c_{au}^2}{h_{au}}$$

$$= \frac{\left(1 - \frac{1}{137.035999074626^4}\right) \times \left[112 \times \left(168 - \frac{1}{3} + \frac{1}{12 \cdot 47} - \frac{1}{14 \cdot 112 \cdot (2 \cdot 173 + 1)}\right)\right]}{4 \cdot 157 / 100}$$

$$= 2990.26512565757$$

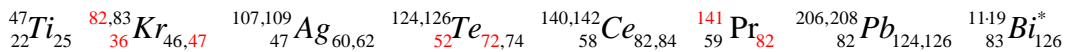
$$v_{1/au} = \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{2 \cdot (2 \cdot 3 \cdot 5 \cdot (2 \cdot 3 \cdot 5 \cdot (2 \cdot 83 + 1) + 1) - 1) + \frac{11}{47}} \right) \right]^2$$

$$= 2990.26512565757$$



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$$v_{1/au} = \left[5 \times \left(11 - \frac{1}{15} + \frac{1}{300} - \frac{1}{47 \cdot (4 \cdot 3 \cdot 13 \cdot 41 + 1) - \frac{36}{47}} \right) \right]^2 = 2990.26512565757$$



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5. Composition of the Universe

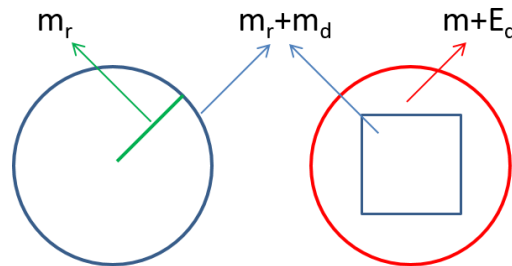
In the above equations of the creation of the universe, m_r corresponds to the mass of regular matter in the universe, and m_d corresponds to the mass of dark matter in the universe [4].

$$m_r + m_d = \frac{2}{c_{au}^4} \approx 5.67 \times 10^{-9}$$

$$\frac{m_r + m_d}{m_r} = (2\pi)_{au} = 6.28$$

$$\frac{m_r}{m_d} = \frac{0.90 \times 10^{-9}}{4.77 \times 10^{-9}}$$

So in the universe after the Big Bang and subsequent annihilation of electron and positron, 0.90×10^{-9} of regular matter and 4.77×10^{-9} of dark matter survived (the original energy to create the universe is 2, and both electron mass and positron mass are very near to 1). This can explain the mystery of matter and antimatter imbalance in the universe, and can explain the composition of regular matter and dark matter in the universe (**Fig. 1**). And our results are consistent with the measurements.



m_r : regular matter m_d : dark matter
 $m = m_r + m_d$ E_d : dark energy
 $(m_r + m_d)/m_r = 6.28$ $(m + E_d)/m = 3.14$
 $m_r/m_d/E_d \approx 5.07/26.78/68.15$

Fig 1. Composition of the Universe

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Appendix I: Research and Writing History

Section	Page	Writing Period	Location	Version
whole paper	1-7	2022/9/15-12/20	Chengdu-Shanghai	viXra:2212.????v1

Note: date was recorded according to Beijing Time.