

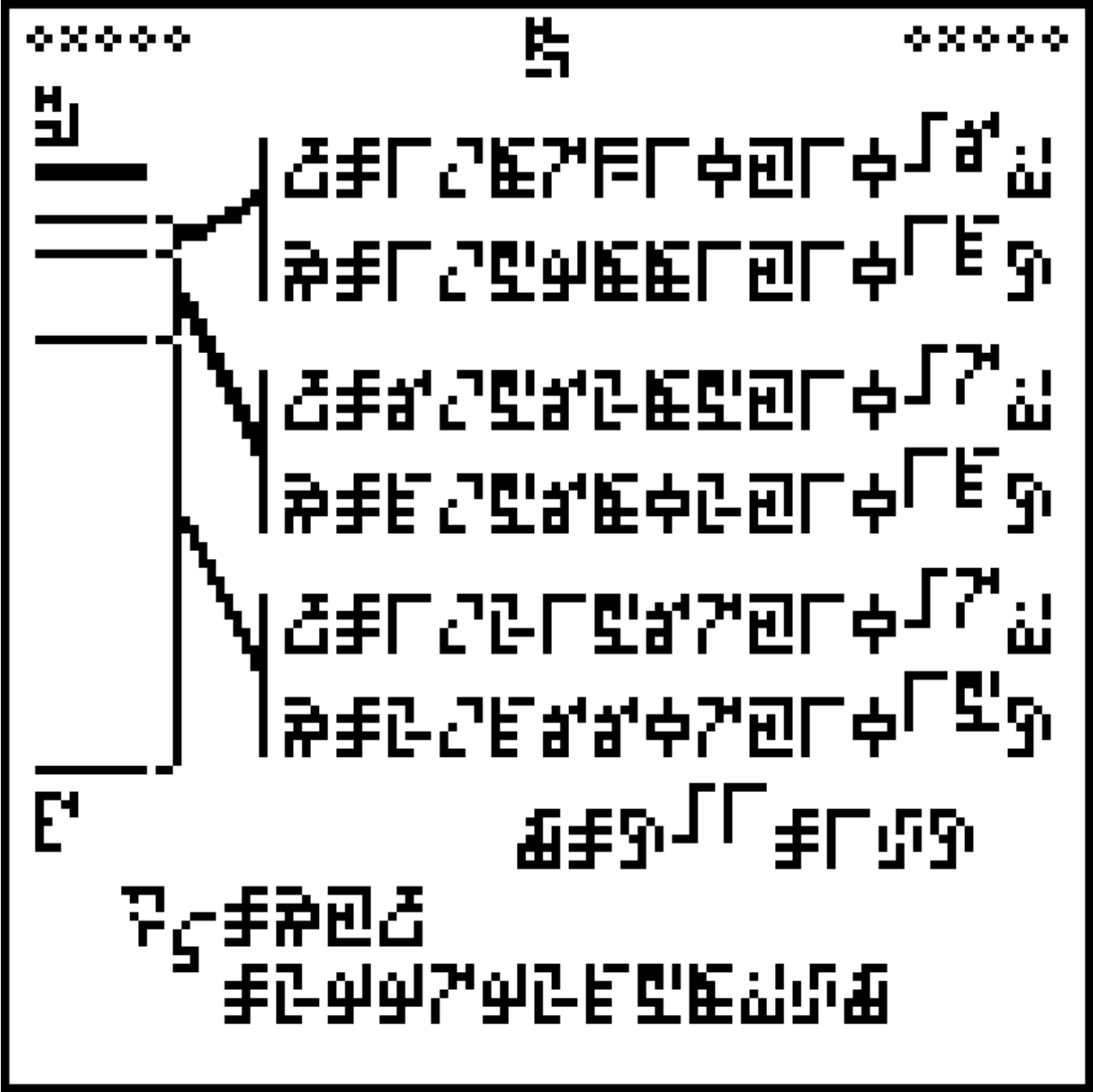
The Universe of Discourse

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A message to the aliens, part 8/23 (time and space)

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This is page 8 of the [Cosmic Call](#) message. An explanation follows.



The 10 digits are:

0 1 2 3 4 5 6 7 8 9

The main feature of this page is a diagram of the electron energy levels for a hydrogen atom, annotated at the top with the glyph for hydrogen and at the bottom with the glyph for energy . The four lowest levels are shown, with the lowest level (the ground state) at the bottom. Above these is a thicker bar representing the way the higher energy levels



all pile up into a smear. If the bottom level is at 0 and the smear is at 1, then the three intermediate levels are shown at approximately their exact values of $\frac{3}{4}$, $\frac{8}{9}$, and $\frac{15}{16}$; these are given by the [Rydberg formula](#).

The aliens should be familiar with hydrogen. Normally a hydrogen atom's sole electron is in the ground state. If a photon couples with the electron, say because starlight is falling on the atom, or someone has applied an electric current to it, the electron may jump up to a higher quantum state. (This is the only correct use of the phrase "quantum leap".) When it drops back down, it will emit a photon. But the energy of the emitted photon must be one of a few particular values, corresponding to the difference between the old and the new energy level; the electron never drops down partway to the next level. An incandescent cloud of hydrogen gas will not typically glow in every possible color; it will emit light in only a few particular, characteristic wavelengths, and these colors can be separated with a spectroscope. The wavelengths of these characteristic colors of light, visible everywhere the message is likely to reach, provide a basis for defining the meter.

For example, the second pair of numbers labels the transition from the $n = 3$ to the $n = 2$ state, and an electron transiting between these two states will always emit a photon with a wavelength of 656.2852 nanometers and a frequency of 456.8021 terahertz, and these are the two numbers in the pair. The product of the two numbers in each pair is a constant, which should further confirm to the recipients that they have the right interpretation. The constant product is close to 299792458, which is the speed of light in meters per second. This defines four glyphs, for wavelength and frequency, and meters and hertz.

⌘ ⌘ ⌘ ⌘
wavelength frequency meters hertz seconds

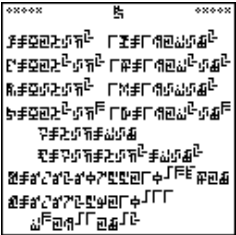
The following item



defines the second ⌘ as the inverse of the hertz (written as Hz^{-1} and as $1 \div \text{Hz}$).

Finally, the speed ⌘ of light ⌘ is given, first theoretically, as the product of wavelength and frequency ⌘⌘ and then numerically, as 299792458 meters per second ⌘⌘.

The [next article](#) will discuss page 9, shown at right. (Click to enlarge.) Try to figure it out before then.



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