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Editorial

How Quantum Jumps Create the Intrinsic Colors of the Elements

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Abstract

Niels Bohr developed the model of the atom in which energy levels of electrons are discrete, that electrons revolve in stable orbits around the atomic nucleus and can quantum jump from the second highest energy level (orbital) to the highest energy level (outermost orbital). As an electron drops back from the outermost orbital, the energy it loses is emitted as a photon. The 6 elements in the periodic table in which quantum jumps cannot occur are colorless. All 90 elements in which quantum jumps occur have an intrinsic color that is imparted to them by the predetermined steady frequency of each quantum jump. Thus, quantum jumping is the only factor which explains the specific color of every element in the periodic table.

Keywords: *Atomic Physics; Photons; Quantum Mechanics; Quantum Jumping*

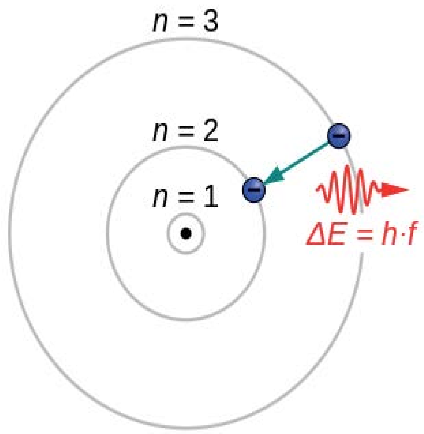
Introduction

The photon is a minute energy packet. of electromagnetic radiation. This concept originated in Albert Einstein's explanation of the photoelectric effect, in which he proposed the existence of discrete energy packets during the transmission of light [1]. The energy of a photon depends on radiation frequency. There are photons of all energies from high energy gamma- and X-rays, through visible light, to low-energy infrared and radio waves. All photons travel at the speed of light [2].

A photon is massless, stable, has no electric charge, and is considered to be an elementary particle [3]. If the photon were not entirely massless, it would be unable to travel at the speed of light.

Niels Bohr developed the model of the atom in which energy levels of electrons are discrete, that electrons revolve in stable orbits around the atomic nucleus and can quantum jump from the second highest energy level (orbital) to the highest energy level (outermost orbital). As an electron drops back from the outermost orbital, the energy it loses is emitted as a photon [4].

Unlike an electromagnetic wave, a photon cannot be of a color. Instead, a photon corresponds to light of a given color depending on its energy of emission. The human eye perceives red light at approximately 2 electric volts (eV), blue light at about 3 eV, with all visible colors in between.



Atomic Structure

Figure 1: An electron moving from quantum level n=3 to n = 2 and releasing a photon

Every element in the periodic table has a unique atomic structure that is determined by its electron configuration [5], Electron configurations describe each electron as moving independently in an orbital, in an average field created by all other orbitals [6]. Electrons are able to move from one configuration to another by means of quantum jumping. Typically, it takes a few nanoseconds or less for an electron to jump from its quantized energy level to the next highest quantized level [7].

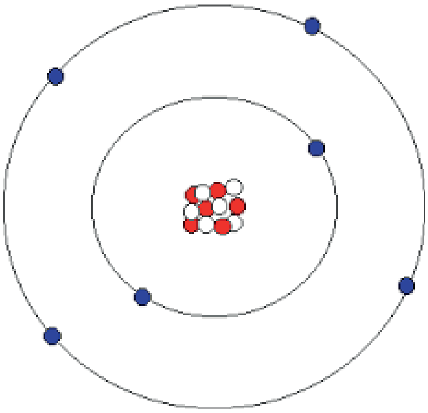


Figure 2: Structure of the Carbon Atom

In the carbon atom there are two electrons in the 1st level orbital and four in the 2nd level orbital. At what may be millions of times per second, an electron from the first level jumps to the second level and jumps back again. As it returns to its former level, it emits a photon.

Quantum jumps are always to the highest energy level orbital, and always return to the second highest level orbital from whence they came. Quantum jumps occur only in atoms in which outer orbitals have space to accommodate an additional electron.

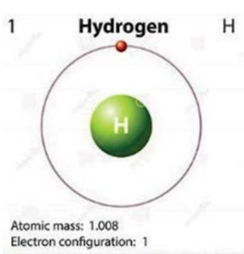
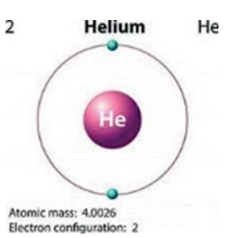
Quantum jumping cannot happen in hydrogen and helium because these elements have only one orbital. Hydrogen and helium do not emit photons. Thus, they are invisible to us.

Quantum jumping also cannot happen in elements which have full outer orbitals. These include neon, argon, krypton, xenon, and radon. None of these gases emits photons. All of them are invisible to us.

Frequency of Emission of Photons

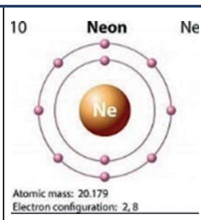
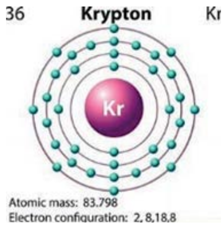
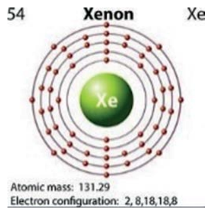
Quantum jumps, long assumed to be instantaneous and random, have recently been discovered to be gradual and predictable [8]. With a super high-speed monitoring system, researchers can spot when a quantum jump is about to take place. Their experimental results indicate that the jump evolution is continuous, coherent, and deterministic [9].

Elements with Only One Orbital

Hydrogen H	Colorless	
Helium He	Colorless	

Because hydrogen and helium have only one orbital, quantum jumping is impossible for them. This is why these elements are colorless.

Elements with Complete Outer Orbitals

Neon 2,8	Colorless	
Argon 2,8,8	Colorless	
Krypton 2,8,18,8	Colorless	
Xenon 2,8,18,18,8	Colorless	

Quantum jumping is also impossible for elements that that have full outer orbitals (i.e., neon, argon, krypton, xenon). Their outer orbitals cannot accommodate the addition of another electron. This is why these elements are colorless.

How the Eye Perceives Colors

Color is the perception of the energy and frequencies of light that reach our eyes. Light receptors within the eye detect light over a range of frequencies and transmit messages to the brain, which interprets each frequency as a specific color.

Table 1: The Visible Spectrum

Color	Frequency [10]	Energy [10]
Red (limit)	4.29 x 10^{14} Hz	1.77 eV
Red	4.62 x 10^{14} Hz	1.91 eV
Orange	5.00 x 10^{14} Hz	2.06 eV
Yellow	5.16 x 10^{14} Hz	2.14 eV
Green	5.45 x 10^{14} Hz	2.25 eV
Cyan	5.99 x 10^{14} Hz	2.48 eV
Blue	6.66 x 10^{14} Hz	2.75 eV
Violet (limit)	7.50 x 10^{14} Hz	3.10 eV

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Table 2: Colors of the Elements

Electrons	Element		Configuration	Color
3	Lithium	Li	2,1	silvery white
4	Beryllium	Be	2,2	white-grey metallic
5	Boron	B	2,3	black-brown
6	Carbon	C	2,4	black metallic
7	Nitrogen	N	2,5	bluish green (as a solid)
8	Oxygen	O	2,6	pale blue (as a solid)
9	Fluorine	F	2,7	very pale yellow
11	Sodium	Na	2,8,1	silvery white metallic
12	Magnesium	Mg	2,8,2	shiny grey
13	Aluminum	Al	2,8,3	silvery grey metallic
14	Silicon	Si	2,8,4	blue-grey
15	Phosphorus	P	2,8,5	white, red, violet, or black metallic
16	Sulphur	S	2,8,6	lemon yellow
17	Chlorine	Cl	2,8,7	pale yellow-green
19	Potassium	K	2,8,8,1	silvery white
20	Calcium	Ca	2,8,8,2	dull grey-silver with pale yellow tint
21	Scandium	Sc	2,8,8,3	silvery white
22	Titanium	Ti	2,8,8,4	silvery grey-white metallic
23	Vanadium	V	2,8,8,5	blue-silver-grey
24	Chromium	Cr	2,8,8,6	silvery metallic
25	Manganese	Mn	2,8,8,7	silvery metallic
26	Iron	Fe	2,8,8,8	lustrous metallic with greyish tinge
27	Cobalt	Co	2,8,8,9	lustrous bluish grey
28	Nickel	Ni	2,8,8,10	lustrous metallic silver with gold tinge
29	Copper	Cu	2,8,8,11	red-orange metallic luster
30	Zinc	Zn	2,8,8,12	silver-grey
31	Gallium	Ga	2,8,8,13	silvery blue
32	Germanium	Ge	2,8,8,14	greyish white
33	Arsenic	As	2,8,8,15	grey
34	Selenium	Se	2,8,8,16	grey metallic
35	Bromine	Br	2,8,8,17	reddish-brown
37	Rubidium	Rb	2,8,8,18,1	whitish grey
38	Strontium	Sr	2,8,8,18,2	silvery white metallic, pale yellow tint
39	Yttrium	Y	2,8,8,18,3	silvery white
40	Zirconium	Zr	2,8,8,18,4	silvery white
41	Niobium	Nb	2,8,8,18,5	grey metallic
42	Molybdenum	Mo	2,8,8,18,6	grey metallic
43	Technetium	Te	2,8,8,18,7	shiny grey
44	Ruthenium	Ru	2,8,8,18,8	silvery white metallic
45	Rhodium	Rh	2,8,8,18,9	silvery white metallic
46	Palladium	Pd	2,8,8,18,10	silvery white
47	Silver	Ag	2,8,8,18,11	silver
48	Cadmium	Cd	2,8,8,18,12	silvery bluish grey metallic
49	Indium	In	2,8,8,18,13	silvery grey, lustrous
50	Tin	Sn	2,8,8,18,14	silvery white
51	Antimony	Sb	2,8,8,18,15	silvery grey, lustrous
52	Tellurium	Te	2,8,8,18,16	silvery grey, lustrous
53	Iodine	I	2,8,8,18,17	metallic grey, lustrous (as a solid)
55	Cesium	Cs	2,8,8,18,18,1	silvery golden
56	Barium	Ba	2,8,8,18,18,2	silvery grey, pale yellow tint
57	Lanthanum	La	2,8,8,18,18,3	silvery white
58	Cerium	Ce	2,8,8,18,18,4	silvery white
59	Praseodymium	Pr	2,8,8,18,18,5	greyish white
60	Neodymium	Nd	2,8,8,18,18,6	silvery white

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61	Promethium	Pm	2,8,8,18,18,7	silvery white metallic
62	Samarium	Sm	2,8,8,18,18,8	silvery white
63	Europium	Eu	2,8,8,18,18,9	silvery white, pale yellow tint
64	Gadolinium	Gd	2,8,8,18,18,10	silvery white
65	Terbium	Tb	2,8,8,18,18,11	silvery white
66	Dysprosium	Dy	2,8,8,18,18,12	silvery white
67	Holmium	Ho	2,8,8,18,18,13	silvery white
68	Erbium	Er	2,8,8,18,18,14	silvery white
69	Thulium	Tm	2-8-8-18-18-15	silvery grey
70	Ytterbium	Yb	2,8,8,18,18,16	silvery white, pale yellow tint
71	Lutetium	Lu	2,8,8,18,18,17	silvery white
72	Hafnium	Hf	2,8,18,32,10,2	steel grey
73	Tantalum	Ta	2,8,18,32,10,3	grey-blue
74	Tungsten	W	2,8,18,32,10,4	greyish white, lustrous
75	Rhenium	Re	2,8,18,32,10,5	silvery-greyish
76	Osmium	Os	2,8,18,32,10,6	silvery, blue cast
77	Iridium	Ir	2,8,18,32,10,7	silvery white
78	Platinum	Pt	2,8,18,32,17,1	silvery white
79	Gold	Au	2,8,18,32,18,1	metallic yellow
80	Mercury	Hg	2,8,18,32,18,2	silvery liquid, shiny
81	Thallium	Ti	2,8,18,32,18,3	silvery white
82	Lead	Pb	2,8,18,32,18,4	metallic grey
83	Bismuth	Bi	2,8,18,32,18,5	brownish silver, lustrous
84	Polonium	Po	2,8,18,32,18,6	silvery grey
85	Astatine	At	2,8,18,32,18,7	silvery
87	Francium	Fr	2,8,18,32,18,8,1	silvery
88	Radium	Ra	2,8,18,32,18,8,2	silvery white metallic
89	Actinium	Ac	2,8,18,32,18,9,2	silvery white, blue glow
90	Thorium	Th	2,8,18,32,18,10,2	silvery
91	Protactinium	Pa	2,8,18,32,20,9,2	silvery metallic luster
92	Uranium	U	2,8,18,32,21,9,2	silvery grey metallic
93	Neptunium	Np	2,8,18,32,22,9,2	silvery white
94	Plutonium	Pu	2,8,18,32,24,8,2	silvery white
95	Americium	Am	2,8,18,32,25,8,2	silvery white
96	Curium	Cm	2,8,18,32,25,9,2	silvery metallic

Five of the seven elements with one electron in their outer orbital are silvery white in color (Li, Na, K, Pt, Fr). One is silvery golden (Cs). One is whitish grey (Rb).

Five of the eight elements with two electrons in their outer orbital have grey in their color (Be, Mg, Ca, Ba, Hf). Three are of a silvery color (Sr, Hg, Ra).

All elements having seven orbitals are silvery in color (Fr, Ra, Ac, Th, Pa, U, Np, Pu, Am, Cm).

Each element in the periodic table has a steady frequency with which its electrons jump back and forth between orbitals giving off light. The frequency of each quantum jump generates a unique frequency for that element, which frequency is experienced by the human eye as a specific color.

Conclusion

The 6 elements in the periodic table in which quantum jumps cannot occur are colorless. All 90 elements in which quantum jumps do occur have an intrinsic color that is imparted to them by the predetermined steady frequency of each quantum jump. Thus, quantum jumping is the only factor which explains the specific color of every element in the periodic table. Light receptors within the eye detect the frequencies of photons emitted by the elements and transmit messages to the brain, which interprets each frequency as a given color.

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