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The Periodic Law of Particles

Shanshi Zhan

【Abstract】 A statistical analysis of particles shows that particles have an overall and regular relationship. All particles occupy a due amount of space-time according to their attributes. Particles with similar attributes form families. The stability of particles in the same family decreases with their increase in mass (energy). Between families, periodic changes of stability and instability are shown. This paper is based on the classification of many particles. All particles are included in the particle periodic table (PPT) established herein. The PPT sums up the regularity of particle contact and predicted (supposed) new particles.

【Keywords】 Particle; Periodicity; Supposition; Attribute; Polarity

1. Introduction

All particles occupy a due amount of space-time according to their attributes (properties, mass, life span, charge or polarity, motion, spin, interaction, etc.), and there should be a regular relationship that unites all particles into one system.

Classifying and queuing the hundreds of particles that have been discovered and sorting out a clue from the chaos is very meaningful. A successful classification of particles should not only be able to summarize all known particles into a scheme, but should also be able further to predict the existence of new particles on this basis^[1].

Considering the steps from the discovery of electrons (1897) to the establishment of the nuclear model of the atom (1911), from the presentation of atomic theory (1802) to the birth of the periodic table of elements (1869), from the four classifications of baryons, mesons, leptons and photons to the Sakata (1956) composite particle model^[2] and from the hadron octuple state (1961) to the standard model (1964), particle physics has overcome many difficulties and has not stopped. The great success of the standard model solved the problem of hadron-level composite particles being composed of different basic particles (quarks) and participating in strong, electromagnetic and weak interactions, resulting in the particle mass mechanism-Higgs mechanism^[3-4]. However, the standard model could not explain the structure and connection of lepton levels. Moreover, quarks themselves are also composite particles (having different color charges, fractional charges and being able to participate in strong-electromagnetic-weak interactions). The development of physics has reached another node-a new crossroads.

In this paper, known particles with similar attributes are called a "family" according to the

attributes of the particles. Particles of the same family are arranged horizontally in order of increasing mass and are named for their most characteristic features. For example, γ (photons), g (graviton) and M (magneton) are members of the quantum family; e , μ , and τ are members of the lepton family; π , K , η , and D are members of the meson family; p , n and Λ are members of the nucleon family; Q , Σ , Ξ , and Ω are members of the baryon family; and W , Z and T are members of the hyperon family (i.e. beyond the meaning of atoms). In addition, there is the atomic family (the existing 118 elements). Using the principle of symmetry^[5], it is also assumed that including the strange particle family and giant particle family with their corresponding particles, there exist a total of nine particle families. They are arranged vertically in order of increasing size according to the attributes of each particle family and the masses of their starting particles, and are represented by graphs, so that relatively scattered particles form a large family of particles – the particle periodic table (PPT).

Table 1 PPT

1.1 PPT

Most of the particles listed in the PPT are characteristic, representative and relatively stable main particles. The PPT classifies the nine families of known and assumed particles into three series as follows: The quantum family, strange family and lepton family constitute the lepton series; the meson family, nucleon family and baryon family make up the baryon series; and the atomic family, hyperon family and giant particle family comprise the giant particle series. Some particle families are divided into main families and subfamilies. Some of them are in pairs, some are in clusters, and some are particle systems (such as photon systems and atomic systems) formed by numerous particles.

1.2 Resonance states and isotopes

Particle physics divides particles into two categories. Those that fail to decay through strong interactions are called stable particles. Particles that decay through strong interactions are called resonance states. Therefore, the difference between the resonance state and the stable particle lies in the different interaction mechanism of decay. When the life is shorter than $10^{-10} \text{ s} \sim 10^{-12} \text{ s}$, the particle decays to the final state after a certain time, which is called the resonance state.

In 1910, the British scientist F. Soddy proposed a hypothesis that there are variations of elements with different atomic masses and radioactivity but the same physical and chemical properties. These variations should be at the same place on the periodic table, called isotopes.

Since both resonance states and (radioactive) isotopes have characteristics common to many particles and they both easily decay, resonance states and isotopes are listed separately.

Resonance states include the meson, nucleon, baryon, hyperon and giant particle types. Isotopes can be divided into stable isotopes and radioactive isotopes.

Table 2 Particle resonance states and isotope classification

2. Periodic law of particles

In order to illustrate the periodic law of particles, we take each particle family as a period, with a total of nine periods represented by the Roman numerals I-IX.

2.1 Stability and instability show periodic changes

From the PPT, one can see that the odd-numbered periods (I, III, V, VII, IX) are the quantum, lepton, nucleon, atomic and giant particle families. In these families are the real-world photon, electron, nucleon and atomic (γ , e, p, n) particles. The main feature of these families is that they possess space and time^[6], and thus greater stability. Particles of the strange, meson, baryon and hyperon families of even-numbered periods (II, IV, VI, VIII) decay easily or exist independently with difficulty and are relatively unstable. With the change in period, particles also change from stable (relative, the same below) to unstable, and from unstable to stable periodicity.

2.2 Periodicity of mass

In particles with known masses, the mass of the end particle of each period is greater than that of the starting particle of the next period. For example (lepton) $\tau > \pi$ (meson), (meson) $D > P$ (nucleon), (nucleon) $\Lambda^+ > Qu$ (baryon), (baryon) $\Omega^- > H$ (atomic), $Rg(atomic) > H^{+*}$ (hyperon) and (hyperon) $\Upsilon^0 > G^{+*}$ (giant particle). The same is true for resonance particles: meson type $g1680 > N940$ (nuclear type), nuclear $N3755 > \Delta 1236$ (baryon type), $\Delta 3230 > \Lambda 1115$, $\Lambda 2585 > \Sigma 1190$ and $\Sigma 3000 > \Xi 1320$.

2.3 Particle mass (energy) of the same period is inversely proportional to its stability

The mass (energy) of most particles increases and their stability decreases. From the PPT, one can see that within the same period of particles, stability (life) is reduced with increasing mass: $e \rightarrow \mu \rightarrow \tau$, $\pi \rightarrow K \rightarrow D$, $p \rightarrow n \rightarrow \Lambda$ and $\Sigma \rightarrow \Omega$. The same is true of the atomic family: H to Bh, or F to Bh. In the photon system of the quantum family, the stability of X-ray and gamma rays with higher energy (frequency) is also poor.

2.4 Periodic transition

In the PPT, the life of the particles at the end of a stable period is relatively short, with a degradation of stability and a tendency to transition to an unstable period. For example, the lepton family τ , nucleon family Λ , and the atomic family actinide elements. In addition, subfamilies and even number periods also have transitional phenomena.

Periodic laws exist even though the length of each period is different.

3. Other laws of particles

3.1 Correlation between spin^[7] (J) and period

Periods I, IV and VIII are bosons, which have integral spin (0, 1, and 2) and are subject to Bose-Einstein statistics. Periods II, III, V, VI, IX are fermions, which have odd half-integral spins (1/2, 3/2) and obey Fermi-Dirac statistics. Fermions satisfy the Pauli exclusion principle^[8]; The atomic family of period VII is distinguished by odd and even numbers of the nucleon p.

3.2 Particle pairs (doubles), particle clusters and particle systems

Particle pairs are formed for e^- and e^+ ; μ^- and μ^+ ; and τ^- and τ^+ . Positive and negative particles are also particle pairs^[9].

For the cases of π^0, π^+, π^- ; K^+, K^-, K^0 ; $D^0, D^+, D^-, D^+S, D^-S$; $\Sigma^+, \Sigma^0, \Sigma^-$; Ξ^{+*}, Ξ^0, Ξ^- and $\Delta^{++}, \Delta^+, \Delta^0, \Delta^-$, in which particle clusters form, the first may be called a π meson cluster. These are hereinafter referred to as a π cluster. Similarly, we have the k meson cluster, D meson cluster, Σ baryon cluster, Ξ baryon cluster and Δ baryon cluster. Particles of some resonances and isotopes can also be seen as particle clusters, such as N1470, N1520, N1670, N1700 (N resonance clusters) and ^{64}Zn , ^{66}Zn , ^{68}Zn , ^{70}Zn (Zn isotope clusters).

The photon system is formed by a large number of different light particles or photons and 118 elements constitute the atomic system.

Light particles tend to come in pairs, heavy particles tend to cluster, and multiple particles tend to form a system.

4. Families and series of particles

4.1 Quantum family

The quantum family should be a large family, including all photons (γ), gravitons (g), and magnetons (M).

4.2 Strange family

The strange family belongs to the lepton series and consists of unstable-state particles, which particles are called strangons (strange particles).

4.3 Lepton family

The main constituents of the lepton family are charged particles, including the very familiar electron. There also exist μ and τ heavy lepton, etc. The subfamily consists of the uncharged ν_e, ν_μ, ν_τ , etc.

4.4 Meson family

The baryon number (B) of particles of the meson family is 0, which nevertheless is put in the baryon series because:

- (1) as hadrons with other baryons, they participate in strong interactions [2].
- (2) the meson family is the transition family of lepton -baryon.
- (3) the mass of most mesons approaches or exceeds that of nucleons.

Between π and k , η^0 and D , there should be other particles besides the assumed E meson.

4.5 Nucleon family

The main families P and N of the nucleon family are important particles that make up the real world. However, the subfamily Λ has poor stability.

4.6 Baryon family

The baryon family has the quality of containing more than the nucleon particles, such as Q , Σ , Ξ , Ω and other particles. It was originally called the hyperon family, because in addition to the atomic family, there are also particles with masses exceeding those of the atomic family. Moreover, Q , Σ , Ξ and Ω belong to the baryon series, so this family has been renamed the baryon family to retain its baryon number and other properties. Among these, Q_u , Q_d and Q_s form the light baryon (smallest of the baryons) particles. According to the principle that heavy particles cluster easily, the Ξ baryon cluster should have Ξ^+ particles. In this subfamily, besides Ω^- there may be a more massive particle and electrically neutral particles.

4.7 Atomic family

The atomic family is included in the system of particle physics, because atoms are composite particles of e, p and n, which have spins of 1/2, 0 and 1, respectively. The atomic family is period VII in the PPT and belongs to the giant particle series. [The letter plus a circle represents the probability cloud of electrons, such as: $\textcircled{A}$ $\textcircled{B}$ $\textcircled{C}$

$\textcircled{A}^+(H, Li, Be, B, Na, Mg, Al)$; $\textcircled{A}^\pm(C, N, Si)$; $\textcircled{A}^-(O, F, S, Cl)$.

$\textcircled{B}^+(Cu, Zn, Ga, Ag, Cd, In)$; $\textcircled{B}^\pm(Ge, As, Sn, Sb)$; $\textcircled{B}^-(Se, Br, Te, I)$.

$\textcircled{C}^0(He, Ne, Ar, Kr, Xe, Rn)$].

4.8 Hyperon family

The new hyperon family has the quality of containing more than only the atomic particles. These other particles have no shell structure and are less stable particles. Found in period VIII of the PPT, this family belongs to the giant particle series. This main family may contain particles consisting of four quarks (QQQQ), subject to further study.

The intermediate bosons W^+ , W^- , and Z^0 belong to a subfamily. They are gauge field particles with enhanced stability. $W^\pm$ and Z^0 can have a static mass and theory predicts that they will have a mass of 80 to 100 gigaelectron volts (GeV).

4.9 Giant particle family

The giant particle family contains particles with very large mass, which are more stable than hyperons and are called giantons (giant particles). The pentaquark particle discovered on July 14, 2015 may be a gianton.

4.10 Series of particles

The series and families of particles can reflect both the similarity and peculiarity of particles.

4.10.1 Lepton series

Lepton series particles have similar speeds of motion (C). The lepton family has the same lepton number (L) and particle charge of the main family (Q). The subfamilies of leptons, and the strange and quantum families are not charged and they are polar particles. Most of them are dipole particles – that is, plus or minus polarity, with the antiparticle being itself!

4.10.2 Baryon series

All particles in the baryons series can be charged (neutral particles are just charge neutralization). All particles except those in the meson family have the same baryon number (B).

4.10.3 Giant particle series

Due to the large range of mass, it is impossible for members of this series to have the same giant particle number (G). The atoms of the atomic family are the basis of the tangible (visible) world.

4.11 Main family and subfamily

Main families fully display the characteristics of their own family, especially those of the starting particle. The subfamilies show a transitional trend, that is, the characteristics of the main family gradually fade away.

5. Conclusion

Based on the classifications of many particles, the results of statistical analysis of particles show that all particles occupy their due space and time according to their attributes (properties, mass, life span, charge or polarity, motion, spin, interaction, etc.). There is a complete and regular relationship between particles.

5.1 Integrity

The known particles are classified and queued, and the particle swarm formed by particles with similar attributes is called a "family". The same family of particles, arranged horizontally in order of increasing mass and named for their most characteristic and features, thus there are seven particle families.

According to the attributes of each family of particles and the mass of the starting particle, particles are arranged vertically from small to large and are represented by a graph to form a particle table.

According to the integrity and symmetry, we assume that the family of strange particles and the family of giant particles form a whole, ordered and unified particle table.

5.2 Regularity

The masses (energies) of particles in the same family are inversely proportional to their stability. There are periodic changes of stability and instability between particle families – that is, the periodic law – including the periodicity of particle mass, the correlation between spin and period and other laws.

5.3 The PPT includes all particles

Based on summarizing the integrity and regularity of particles, new particles and their corresponding attribute could be predicted by PPT (according to the principle of symmetry and possession). We will continue to explore the secrets of the most micro-particle series – the tachyons (faster-than-light particles) in our follow-up research.

5.4 Relation between the particle periodic law and the standard model

When the e.p.n. group of particles appeared, the "essential relationship between the internal composition of elements and the periodic law of elements" was more fully elucidated. Similarly, the quark theory of the standard model explains the internal structure of the composite particles (hadrons), and perfects the basis for the periodic law of heavy particles. The periodic law of particles and the standard model explain the structure and correlation of heavy particles from different angles.

The preliminary establishment of the PPT requires constant exploration, modification and improvement. Some additional hypotheses must yet be supported by experimental evidence and practice.

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Tab. 1 Particle Periodic table ¹

The periodic variation in stability and instability	period	Series	particle family		Particle (Mass: MeV)								Spin
	I	Lepton series	Quantum family		$g^{\pm}$	γ	$M^{\pm}$						1
	II		Strange family		χ^{+*}	χ^{-*}	$\chi^{\pm*}$						1/2
	III		Lepton family	subfamily	ν^e	ν^{μ} <0.17	ν^{τ} <24						1/2
				main family	e^- 0.511	e^- 0.511	μ^- 105	μ^- 105	τ^{+*}	τ^- 1777			
	IV	Baryon series	Meson family	M F	π^0 134	π^+ 139	π^- 139						0
				S F	E^*	K^+ 493	K^- 497	K^0 497	η^0 548	D^0 1864	$D^{\pm s}$ 1868	$D^{\pm}$ 1869	
	V		Nucleon family	M F	p^+ 938	n^0 939							1/2
				S F		Λ^0 1115	Λ^+ 2284						
	VI		Baryon family	M F	Q^u 3.3	Q^d 5.8	Q^s 131	Σ^+ 1189	Ξ^0 1314	Q^c 1270	Q^b 4190	Q^t 172000	1/2
				S F	$?^+$		Ω^- 1672		$?^0$				3/2
VII	Giant particle series	Atomic family	M F	A^+	$A^{\pm}$	A^-						1/2, 0, 1	
			S F	B^+	$B^{\pm}$	B^-		O^0					
VIII		Hyperon family	M F	H^*	H^{0*}	H^+*						1	
			S F	W^+ 80400		W^- 80400		Z^0 81000		Υ^0 91187			
IX		Giant particle family	M F	G^{+*}	G^{0*}	G^{+*}						1/2	
			S F										
As the quality (energy) increases, the stability drops $\longrightarrow$													

1. 1.MF=main family;2.SF=subfamily;3. γ = photons, g = graviton, M = magneton; 4. χ^{+*} = strange; 5. ν^e < 7.6ev. 6. E^* = E meson, $D = D(D^0, D^+, D^-, D^s, D^{\pm s}, D^+, D^-)$ meson cluster; 7. $Q^u, Q^d, Q^s, Q^c, Q^b, Q^t$ = Quark, $\Sigma = \Sigma(\Sigma^+, \Sigma^0, \Sigma^-)$ baryon cluster, $\Xi = \Xi(\Xi^{+*}, \Xi^0, \Xi^-)$ baryon cluster; 8. H^* = hyperon; 9. G^* = giant particle; 10. $*$ Predicted particles, mass to be measured.

Tab. 2 Particle Resonance State and Isotope Classification¹

Condition	Type	particle(Mass: MeV)								
Resonance Baryon state	Meson type	A	M*							
		B	ρ^{770}	ω^{784}	K^{*892}	$\eta^{'}^{958}$	δ^{970}	ϕ^{1019}	A_1^{1100}	
		C	B^{1235}	f^{1270}	K_A^{1280}	D^{1285}	A_2^{1310}	E^{1420}	K_N^{1420}	
		D	$f^{'}^{1514}$	ω^{1675}	g^{1680}	...				
		E								
	Nucleon type	A	N^{940}	...						
		B	$N^{1470-1990}$	$N^{2040-2650}$	$N^{3030-3755}$	...				
	Baryon type	A	$\Delta^{1236-1960}$	$\Delta^{2420-2850}$	Δ^{3230-}	...				
		B	$\Lambda^{1115-1870}$	$\Lambda^{2010-2585}$	...					
		C	$\Sigma^{1190-1940}$	$\Sigma^{2000-2620}$	Σ^{3000-}	...				
		D	$\Xi^{1320-1940}$	$\Xi^{2030-2500}$	...					
		E								
	Resonance Giant- particle state	Hyperon type	A	H*						
			B							
		Giant type	A	G*						
B										
Isotope	Atom type	A	Natural isotopes > 300 species and artificial isotopes > 1200.						(omit)	
		B	There are about 300 stable isotopes and 1,500 radioactive isotopes.							

¹ Because there are more particles in resonance states and isotopes, this table only lists part of the particles.
M*,H* and G* are expected (assumed) particles.