

# Algorithm of resonance orders for the objects

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**Abstract.** In mechanical engineering, the object resonance phenomena often occur when the external incident wave frequency is close to object of the natural frequency. Object resonance phenomena get the maximum value when the external incident frequency is equal to object the natural frequency. Experiments found that resonance intension of the object is changed, different objects resonance phenomena present different characteristics of ladders. Based on object orders resonance characteristics, the calculation method of object orders resonance is put forward in the paper, and the application for the light and sound waves on the seven order resonance characteristics by people feel, the result error is less than 1%. Visible in this paper, the method has high accuracy and usability. The calculation method reveals that some object resonance occur present order characteristic only four types, namely the first-orders resonance characteristics, third-orders characteristics, five orders characteristic, and seven orders characteristic.

## 1. Introduction

People have long found that any object has its inherent frequency. It has been more works that the research resonance phenomenon of nature objects has many years when nature objects affected by outside wave, and developed many theories and models, such as vibration modal learning in engineering mechanics etc. It is taken out a lot of works through actual measurement for resonance phenomenon of objects that the peoples have been used by all kinds of precision instruments and methods. But the people ignore the human organs bring us the resonance phenomenon of sound and light feeling. The human organ is able to feel the nature many subtle changes following human organ evolution, and even human design instrument cannot. The human organs feel seven colors of light wave is also a kind of human's own organs precision instrument measuring results. Human organs of the precision instrument bring feelings that the resonance phenomenon by external fluctuation has some properties. While not all objects by external force resonance have these properties, but at least the human organs by external force resonance have the properties of seven resonance orders. Such as human heard sound that (4) fa tone is strongest and the highest tone. From (1) dou tone to (4) fa tone the sound is gradually strengthen, and from the (4)fa tone to (7) xi tone will be gradually diminish. Nature evolution also showed the characteristics of the resonance orders, such as green plants in nature, because the sunlight green light order is location in the center and the energy strongest, but also nature plants evolution is that maximum ways absorb solar energy. It is also looking for ways to present their own form that plants evolution change green.



The article research the phenomenon of both the human eye to feel seven colors of the sun's rays and the human ears hear seven scales of the sound. Why are its seven? Not eight or nine! It is found that the structure of seven resonance orders of the frequency is the middle order of frequencies as the center where other some orders are in both sides of the quasi-symmetrical distribution regularly. On the basis of resonance wave of a quarter wavelength effect, we designed the method for calculating the other six resonant orders on both sides when middle resonant order wavelength knows. The calculation results of the method have good agreement with the reality measured values. In this paper it is found the characteristic of three ring structure of resonance orders that both first ring and second ring out of sides is the symmetry and inner third ring of resonance order is asymmetry or quasi symmetric distribution.

## 2. Wavelength of resonance order calculation formula

Resonance order wavelength of the object calculation formula is

$$L_i = L_c \pm L_c G_{\pm}^R \quad (1)$$

Where the coefficients calculation formula of resonance orders is

$$G_{\pm}^R = \frac{\left(\frac{1}{2}\right)^{R+2}}{1 \mp \left(\frac{1}{2}\right)^{R+2}} \quad (2)$$

Where  $L_i$  is any resonance order frequency corresponding to the wavelength;  $L_c$  is the center order of inherent frequency corresponding to the wavelength.

**When  $R=0$ :**  $L_i = L_c \pm L_c G_{\pm}^0$  where  $G_{\pm}^0 = \frac{1}{3}$ .

Corresponds to two resonances orders around the outer boundary, where is namely the first lap of two resonance orders endpoint wavelengths.

$$L_i = L_c \pm L_c G_{\pm}^0, \text{ where } G_{\pm}^0 = \frac{1}{5}.$$

Corresponds to the second ring of the two resonant orders, where is the second circle inward two resonance orders endpoint wavelengths.

The both first ring and second ring are symmetry on two sides of left and right when  $R=0$ .

**When  $R=1$ :**  $L_i = L_c - L_c G_{\pm}^1$ , where  $G_{\pm}^1 = \frac{1}{9}$ . Corresponds to the third ring of the resonance order where is corresponds to the side of short wavelength of the center frequency.

If there are two endpoints of the center frequency it is selected the endpoint of wavelengths longer for the center frequency. The time having two endpoints wavelength need to calculate that both one endpoint is shortwave endpoint of the center frequency with  $L_i = L_c - L_c G_{\pm}^1$  and other endpoint is the third ring of the resonance order wavelength with  $L_i = L_c - L_c G_{\pm}^1$ .

**When  $R=2$ :**  $L_i = L_c + L_c G_{\pm}^2$ , where  $G_{\pm}^2 = \frac{1}{17}$ .

It corresponds to the endpoint wavelength of the center frequency which is on one side of the long wave direction, and is the third lap long wave side.

Why is it selected the endpoint of wavelengths longer for the center frequency? Because the long

wavelength side resonance wave moment of all three resonance orders is greater than other three resonance orders on one side of short wavelengths. So it need has four endpoint of resonance wave orders to balance on one side of short wavelengths or the third ring is asymmetry to balance.

The third ring is asymmetry on two sides of left and right when both  $R=1$  and  $R=2$ .

### 3. The verification of seven colors of sun light with the method

colors	Frequency(MHz) of reality	Wavelength ( nm ) of reality	Calculation method of this paper	The results	The error	Resonance coefficient
Red	480--405	625--740	$L_{red} = L_{c-green} + L_{c-green} G_+^0$	753.	1.79%	$G_+^0 = \frac{1}{3}$
Orange	510--480	590--625	$L_{orange} = L_{c-green} + L_{c-green} G_-^0$	678.	8.48%	$G_-^0 = \frac{1}{5}$
Yellow	530--510	565--590	$L_{yellow} = L_{c-green} + L_{c-green} G_-^2$	598.	1.35%	$G_-^2 = \frac{1}{17}$
Green	600--530	500--565	$L_{green} = L_{c-green} - L_{c-green} G_-^1$	502.	0.44%	$G_-^1 = \frac{1}{9}$
Chongkwang	620--600	480--500	$L_{chongkw} = L_{c-green} - L_{c-green} G_+^1$	484.	0.89%	$G_+^1 = \frac{1}{7}$
blue	680--620	440--480	$L_{blue} = L_{c-green} - L_{c-green} G_-^0$	452.	2.72%	$G_-^0 = \frac{1}{5}$
Purple	790--680	380--440	$L_{purple} = L_{c-green} - L_{c-green} G_+^0$	376.	0.87%	$G_+^0 = \frac{1}{3}$

Table.1. Seven colors wavelengths calculation result list

Although the orange light calculation error is larger, but does not exclude the error generated by the delimitation of both the red and orange light, because red light band width is 115 nm, orange light band too narrow is 35 nm. If the wavelength of delimitation of both the red and orange light is 660 nm, it may be more reasonable [1].

### 4. Verification for seven resonance orders of sound with the method

Register (1) (2) (3) (4) (5) (6) (7) of seven scales in middle-part, (4) scale is as the center frequency. We apply equation (1) to calculate other six scales wavelength of the sound [2] [3].

Scale	Frequency(Hz) of reality	Wavelength(m) of reality	Method in the paper	Calculation results	The error	Resonance coefficient
(7)	830.61	0.409	$L_7 = L_c - L_c G_+^0$	0.385	6.23%	$G_+^0 = \frac{1}{3}$
(6)	739.99	0.459	$L_6 = L_c - L_c G_-^0$	0.462	0.65%	$G_-^0 = \frac{1}{5}$
(5)	659.33	0.515	$L_5 = L_c - L_c G_-^1$	0.514	0.19%	$G_-^1 = \frac{1}{9}$
(4)	587.33	0.578	$L_4 = L_c = 0.578$	Wavelength of Center frequency		
(3)	554.37	0.613	$L_3 = L_c + L_c G_-^2$	0.612	0.16%	$G_-^2 = \frac{1}{17}$
(2)	493.88	0.688	$L_2 = L_c + L_c G_-^0$	0.693	0.72%	$G_-^0 = \frac{1}{5}$
(1)	440	0.772	$L_1 = L_c + L_c G_+^0$	0.770	0.25%	$G_+^0 = \frac{1}{3}$

Table 2 Seven scales wavelength calculation result in acoustic median list

Scale	Frequency(Hz) of reality	Wavelength(m) of reality	Method in the paper	Calculation results	Calculation error	Resonance coefficient
(7)	415.31	0.818	$L_7 = L_c - L_c G_+^0$	0.771	5.74%	$G_+^0 = \frac{1}{3}$
(6)	370	0.918	$L_6 = L_c - L_c G_-^0$	0.925	0.76%	$G_-^0 = \frac{1}{5}$
(5)	329.63	1.031	$L_5 = L_c - L_c G_-^1$	1.028	0.29%	$G_-^1 = \frac{1}{9}$
(4)	293.67	1.157	$L_4 = L_c = 1.157$	Wavelength of Center, Where $L_4 = 2L_4$		
(3)	277.19	1.226	$L_3 = L_c + L_c G_-^2$	1.225	0.08%	$G_-^2 = \frac{1}{17}$
(2)	246.04	1.381	$L_2 = L_c + L_c G_-^0$	1.388	0.51%	$G_-^0 = \frac{1}{5}$
(1)	220	1.545	$L_1 = L_c + L_c G_+^0$	1.542	0.13%	$G_+^0 = \frac{1}{3}$

Table 3 Seven wavelength scales calculation result in acoustic bass list

Scale	Frequency(Hz) of reality	Wavelength(m) of reality	Method in the paper	Calculation results	Calculation error	Resonance coefficient
(7)	1661.22	0.204	$L_7 = L_c - L_c G_+^0$	0.191	6.37%	$G_+^0 = \frac{1}{3}$
(6)	1479.98	0.229	$L_6 = L_c - L_c G_-^0$	0.230	0.43%	$G_-^0 = \frac{1}{5}$
(5)	1318.52	0.257	$L_5 = L_c - L_c G_-^1$	0.255	0.77%	$G_-^1 = \frac{1}{9}$
(4)	1174.66	0.287	$L_4 = L_c = 0.287$	Wavelength of Center, Where $L_4 = \frac{1}{2}L_4$		
(3)	1108.73	0.306	$L_3 = L_c + L_c G_-^2$	0.303	0.98%	$G_-^2 = \frac{1}{17}$
(2)	987.76	0.3442	$L_2 = L_c + L_c G_-^0$	0.3444	0.05%	$G_-^0 = \frac{1}{5}$
(1)	880	0.386	$L_1 = L_c + L_c G_+^0$	0.382	1.03%	$G_+^0 = \frac{1}{3}$

Table 4 Seven scales wavelength calculation result in acoustic treble list

The calculation errors are big to 5% from table 2(7), table 3(7) and table 4 (7) scales by the comparison. From the calculation results of the calculation model by design in this paper, in table 2 (7) scale wavelength calculated value is 0.385m with coincide to table 4 (i) of the measured wavelength value of 0.386m, and table 3 (7) scale wavelength calculated value is 0.771m with coincide to table 2 (1) scale of the measured wavelength value of 0.772m. Calculation results in this method show a seamless link up for three parts of treble, mediant and bass, and its share a common outside border

order for Fig 1, where horizontal axis is wavelength coefficient of  $\alpha \left( \frac{L_r}{L_c} \right) = 1 \pm G_{\pm}^R$ .

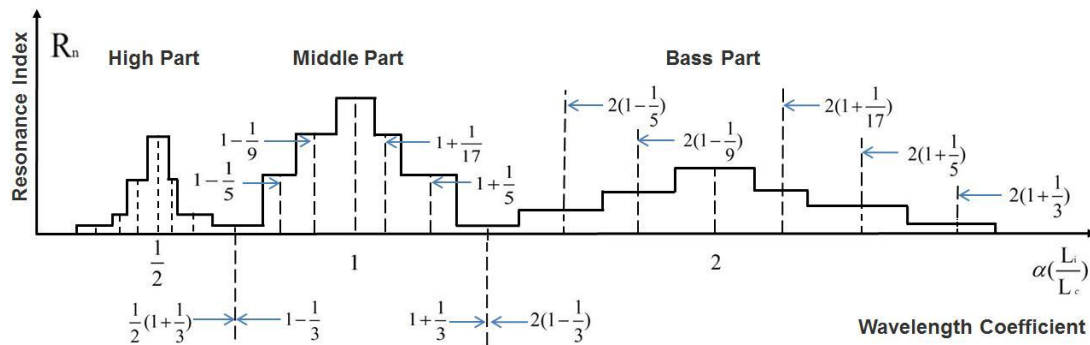


Fig.1. Seven scales of sound distribution schematic diagram in high, median and bass part

The fact in real music it is half-down the chromatic to use for median (7) and the bass sounds ( $\dot{7}$ ) and treble department ( $\dot{7}$ ).

## 5. Conclusion

It can be seen from the above calculation that the resonance order of the object can be presented a first order, the third orders, also five orders, only seven orders, but nine orders is unlikely, because the coefficients of both  $G_{-}^2 = 0.05888$  and  $G_{+}^2 = 0.06666$  are near the convergence, so it can't divide again.

And resonance boundary of the objects is the value of a third wavelength of center natural frequency. It cannot be changed for the value of the resonance frequency boundary. When the absolute value of the difference between foreign incident wavelength and center natural frequency wavelength is less than a third, the resonance will be occurs by the incident wave to response. This is a **third wavelength effect** for beginning resonance of two boundary orders [4][5][6][7][8][9].

## 6. References

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