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Application of MATLAB in University Physics Teaching

Abstract: To make use of MATLAB as the visible sketch interface and data handling in Physics teaching, and developing the physical experiment data handling procedure and contributing to improve the interest in study and study effect of students. With the imitate of true mercury atom’s spectrum, and the hydrogen atom’s colour light spectrum of grating spectrum experiment, and other atoms’ spectrum, elaborate MATLAB application in Optical theory and other experiment teaching.

Keywords: MATLAB application, Imitate of Mercury atom’s spectrum, Hydrogen atom’s spectrum

1 Introduction

Matlab is international accepted as excellent software in science and technology realm and used in most application and development. Its characteristics is to gather the science calculation, painting, system model and procedure language design together, and its function is extremely strong [1, 2]. MATLAB computes a rapid result to science and visible accurately, this help the students to turn the abstract thinking to image thinking, thus better for insight into physical meaning, concept comprehension, regulation discovering, and stir up a student to improve interest, foster the student’s creative ability.

There are too many concepts and Physical regulations that’s very abstract in the University Physics Optical course [3, 4], the theory teaching depend a lot on experiments, especially among them some optical phenomena and regulation lack of detailed mathematical deduce for students so it bring many difficulties for students in their Optical course. The meaning is very important to Provide our students the opportunity of observation about phenomenon in the Optical course teaching, raise their interest in study, then foster the student’s thinking and innovation ability, strengthen our classroom teaching effect.

MATLAB show us the advantage in the class teaching as follows:
1) This software solves our problems simple and save time, can help us avoid a complicated operation so we can put attention to the hypostatic thinking at the physical problem.

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DOI 10.1515/9783110540048-082, © 2017 Yao-Zu Cao and Yi-Min Tian, published by De Gruyter. This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 License.
2) Keeps frank simulation to the physical process. Make use of the software in calculation and make diagram function, it turn very convenient in Physics process simulation.

3) MATLAB is easy to learn and easily understand, the program design language and operation is very simple and convenient, so it can raise a student’s activity in the university.

Certainly, MATLAB is just the assistance of University Physics teaching, it can’t replace the theory teaching. Students should insist on the foundation in control of basic physical knowledge, gradually manage about the making use of MATLAB, so as to promoting their study.

Following imitation carry out with the MATLAB7. 0 software.

To compare with monochrome spectrum simulation, the colourful spectrum of atom light interference and diffraction of computer imitating is really a blank and have never seen discussed in literatures. In the numerously experiments imitating, majority of authors all just only carry on simulation of monochrome [5, 6], colourful light spectrum imitation mostly don't show ideal [7,8]. Some successful colourful light spectrum imitation are finished by Lan haijiang etc. [9]. But the colourful spectrum of the atom light imitation, such as Mercury atom spectrum, Hydrogen atom spectrum etc., don’t find report in literatures.

This article tries to carry on simulation about colourful spectrum of different atoms, and synthesizes according to principle of RGB colour light and makes use of MATLAB visual program, developed to imitate grating spectrum of true mercury, hydrogen experiment and filled up the lack of colourful spectrum data in the university’s Physics teaching.

2 The Colourful Spectrum Emulation of The Mercury Atom Spectrum

Suppose the light grating contains N unit, and width of each transparent slot unit as a, width of each opacity slot unit as b, the grating constant is d, then the light strength distribution of Fraunhofer diffraction as follows[10]:

$$I = I_0 \left( \frac{\sin \alpha}{\alpha} \right)^2 \left( \frac{\sin N \beta}{\beta} \right)^2$$

(1)

In formula (1), $I_0$ means the light strength of center, suppose the diffraction angle is $\theta$, $\lambda$ is the wave-length of monochrome light, then
\[ \alpha = \pi b \sin \theta / \lambda, \quad \beta = \pi d \sin \theta / \lambda, \quad \left( \frac{\sin \frac{\alpha}{\alpha}}{\alpha} \right)^2 \text{ in formula (1) is factor of single slot diffraction,} \quad \left( \frac{\sin \frac{N \beta}{\beta}}{\beta} \right)^2 \text{ represents the factor of multiple light diffraction.} \]

We combine the wave-length of the spectrum of mercury atom and with colour only to should of RGB code value, with the MATLAB tool write true procedure of imitating of a mercury spectrum as follows:

Clear;
Lambda= [607.3, 579.1, 577,491.6, 435.8]*1e-9;
RGB=[1,0.495,0;1,0.98,0;1,0.97,0;0,1,0.5;0,0,1;];
d=1.5e-5;
b=12e-6; N=18;
Bright=8000;
Irgb=zeros (250, 1885, 3);
IW=zeros (250, 1885, 3);
For k=1:5
Theta= (-0.015*pi: 0.00005:0.015*pi);
Phi=2*pi*d*sin (theta)/lambda (k);
Alpha=pi*b*sin (theta)/lambda (k);
If= (sinc (alpha)). ^2;
Idgs= (sin (N*phi/2). /sin (phi/2)). ^2;
I=Idf.*Idgs
For i=1:250
Iw (i,:, 1)=I*RGB(k,1) ;
Iw (i,:, 2)=I*RGB(k,2) ;
Iw(i,:,3)=I*RGB(k,3) ;
End
Irgb=Irgb+Iw;
IW= [];
End
Br=1/max (max (max (Irgb)));
Iall=Irgb*Br*Bright;
Imshow (Iall);
clc

According to formula (1), combine the program showed, we can acquire different effect of colourful spectrum diagrams of the mercury atom, just as showed in figure 1. In this diagram, besides which spectral line of zero class, we can see spectrum of \( \pm 1, \pm 2 \) class and part of class three spectrums. Along with spectral line class turning higher, spectral line turn thinner and acuity, this is concurrent with actual experiment. Reducing grating constant, especially raise the grating constant N, we can remarkably raise the resolution ability of the grating spectrum. To acquire the thin
and sharp spectrum that can satisfy to measure request, we have to consumedly increase the total number of grating, and reduce the grating constant at the same time.

![Fig. 1: Mercury atom colour grating spectrum simulating diagram](image)

### 3 The Colourful Spectrum Emulation of The Hydrogen Spectrum of Ballmer Series

Analysis of the hydrogen atom Ballmer series spectrum is very important in Optical Physics, during the development of Quantum Physics and modern Physics, the research of hydrogen spectrum has an incomparable function. However, because of experiment condition and funds restriction, in majority of colleges, researchers didn't develop the wave-length analysis research of hydrogen spectrum currently, so the students and teachers all could not acquire hydrogen spectrum diagrams of Ballmer series to keep a view about the spectrum, it must be an important missing of Physics experiments.

In this emulation we try to establish different light grating constant, dissimilarity penetrate width, different slot number, we can imitate different parameters of hydrogen spectrum figure. If regulate each parameter by oneself, readers can acquire arbitrary colourful hydrogen spectrum diagram, consumedly enriched people about sight-seeing and comprehension of hydrogen spectrum. Following are program of imitating about hydrogen spectrum with MATLAB. The hydrogen spectrum wave-length draws from [13].

![Fig. 2: Hydrogen atom colour light grating spectra imitate grating](image)

Figure 2 shows the four famous lines of hydrogen atom Ballmer series. Just a hard analysis about the four famous lines, opened the front door of understanding with
atom world and finally caused the birth of Quantum Mechanics and modern Physics. Descend the grating constant, the appropriate increment of opacity sews width, and increment the total number of grating slots, the resolution of hydrogen spectrum consumedly raise.

### 4 Conclusions

Imitate a true mercury atom, hydrogen atom’s colourful spectrum by MATLAB emulation, thus more clearly understand the principle, method, step and substantial etc. Combine Optical experiments and MATLAB Physics teaching, it’s helpful to modern education, and contribute to innovation consciousness in trains about students, and to a student in solve of Physical concepts and regulations, stir up interests in their study and raise the teaching effect. Along with the progress of science and technology, the means of Physical teaching is continuously renewing, the computer can import a visible teaching method in our Physics teaching. Now MATLAB shows a strong graphical function in exhibiting complicated Physics formulas and regulations and thus helps a student goes more deeply into the mystery of Physical phenomenon and regulation.

### References


