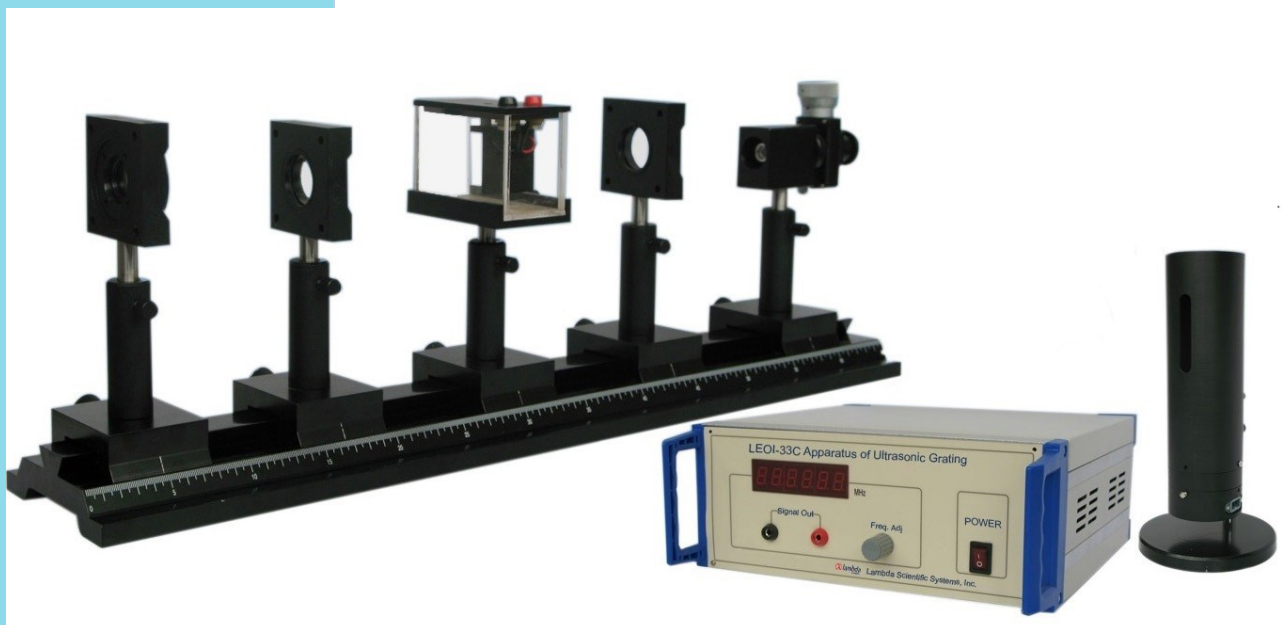
Construct, Conduct & Comprehend Physics Experiments

LEOI-33C Apparatus of Ultrasonic Grating



- High measurement accuracy
- Stable and reliable experimental results
- Suitable for both general & advanced physics labs
- Affordable

The phenomenon of light wave diffracted by ultrasonic in a medium is called ultrasonic induced photo-diffraction (also known as the acousto-optic effect), which is the result of the interaction between light wave and sound wave in the medium. The ultrasonic wave modulates the density of the medium, so that the originally uniform refractive index of the medium becomes periodical changes, i.e. an "ultrasonic grating". When a light beam passes through, it will produce diffraction phenomenon, which can be used to accurately measure the speed of sound waves in the medium.

The LEOI-33C, experimental apparatus of ultrasonic grating, is constructed by placing individual components on an optical rail. Liquid is used as the ultrasonic medium. It allows students to adjust each component independently, and thus strengthens the students' hands-on ability. The apparatus has high measurement accuracy, stable and reliable experimental results, and is suitable for both general and advanced physics labs in colleges and universities.

By conducting experiments using this apparatus, students can achieve following objectives:

1. Understand the experimental principle of the acousto-optic effect.
2. Learn to measure the speed of sound in a liquid using the acousto-optic effect.
3. Learn the skills of optical path alignment.

Specification

Description	Specifications
Ultrasonic signal source	resonance frequency about 10.000 MHz, resolution 0.001 MHz
Slit	Width 0.04 mm, length 6 mm
Lens	focal length 157 mm, effective aperture 28 mm
Ultrasonic cell	dimensions L 80 mm × W 40 mm × H 59 mm
Microscope eyepiece	measurement range 0 - 8 mm, resolution 0.01 mm
Optical rail	length 650 mm, scale 1 mm

Parts

Description	Qty
Main electric unit	1
Low pressure sodium lamp	1
Optical rail	1
Slide	5
Rotary slit disk	1
Lens	2
Measurement eyepiece	1
Ultrasonic cell	1
Support of ultrasonic cell	1
Cable	2
Power cord	1
Instruction manual	1

Light source wavelength $\lambda = (589.3 \pm 0.3)$ nm

Lens L_2 focal length $f = (157.0 \pm 0.4)$ mm

Tested liquid tap water

Liquid temperature $t =$ 12 °c

$V_t = V_0 + \alpha(t - t_0) =$ 1497+2.5×（12−25）=1464 m/s

Signal frequency $\upsilon =$ 9.130 MHz

Table 1 diffraction order k and spectral line position

Order k	Position L_k	$L_{\|k\|} - L_{\|k\|-1}$ (mm)	$(L_{\|k\|} - L_{\|k\|-2})/2$ (mm)	$(L_{\|k\|} - L_{\|k\|-3})/3$ (mm)
-3	1.547	0.583	0.585	0.584
-2	2.130	0.586	0.584	
-1	2.716	0.582		
0	3.298			
1	3.883	0.585		
2	4.499	0.616	0.601	
3	5.069	0.570	0.593	0.590

$$\Delta l_k = \frac{1}{12}\sum\left[L_{|k|} - L_{|k|-1} + (L_{|k|} - L_{|k|-2})/2 + (L_{|k|} - L_{|k|-3})/3\right]$$

$$= \frac{1}{12}(0.583+0.586+\ldots+0.584+0.590)$$

$$= 0.588 \text{ (mm)}$$

$$V = \frac{\lambda f \upsilon}{\Delta l_k} = \frac{589.3\times10^{-9}\times157.0\times10^{-3}\times9.130\times10^{6}}{0.588\times10^{-3}} = 1437 \quad \text{(m/s)}$$

$$E = \frac{|V_t - V|}{V_t}\times100\% = \frac{|1464-1437|}{1464}\times100\% = 1.8\%$$

Example of experiment results

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