

物理实验教学中心

Physics Experiment Center



Measuring low resistance using double bridge

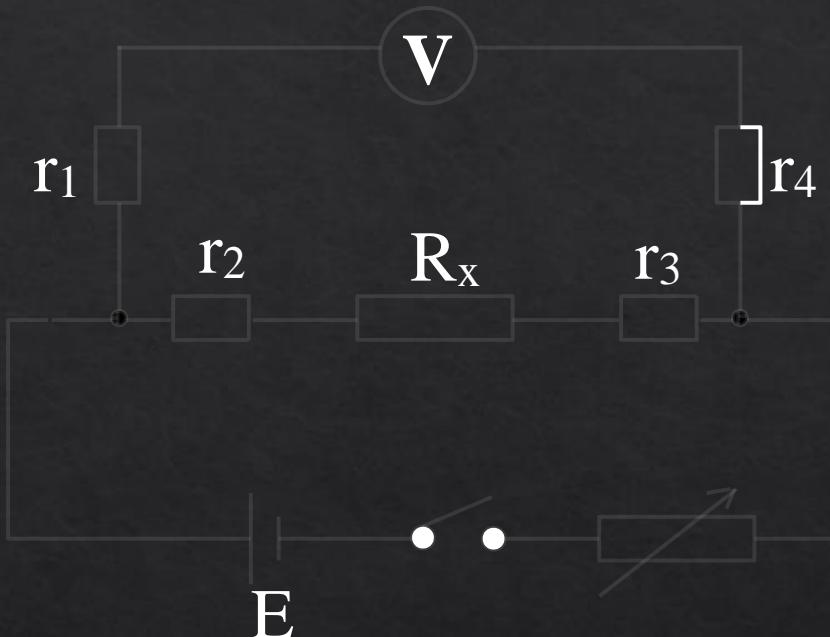
Li Bin
NJUPT

Experiment purpose

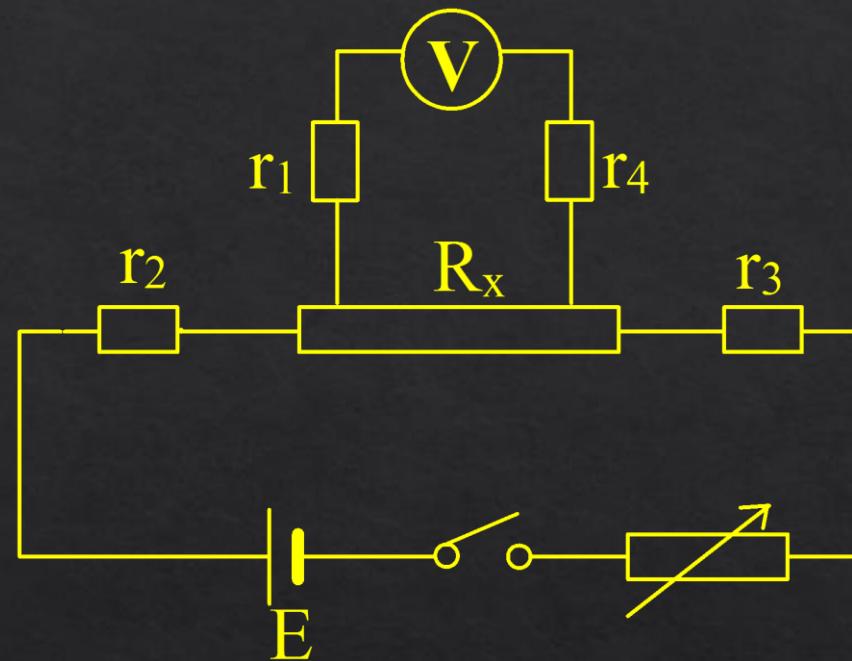
- Know the meaning of four probe method and structure of double bridge ;
- Learn to use double bridge to measure **low resistance** ;
- Learn to measure resistivity of conductor .

Principles

➤ Four Probe Method



- **Measuring resistance using Voltammetry,** contact resistance, conductor resistance, If r_2 and $r_3 \geq R_x$, we can not use this circuit to measure R_x .

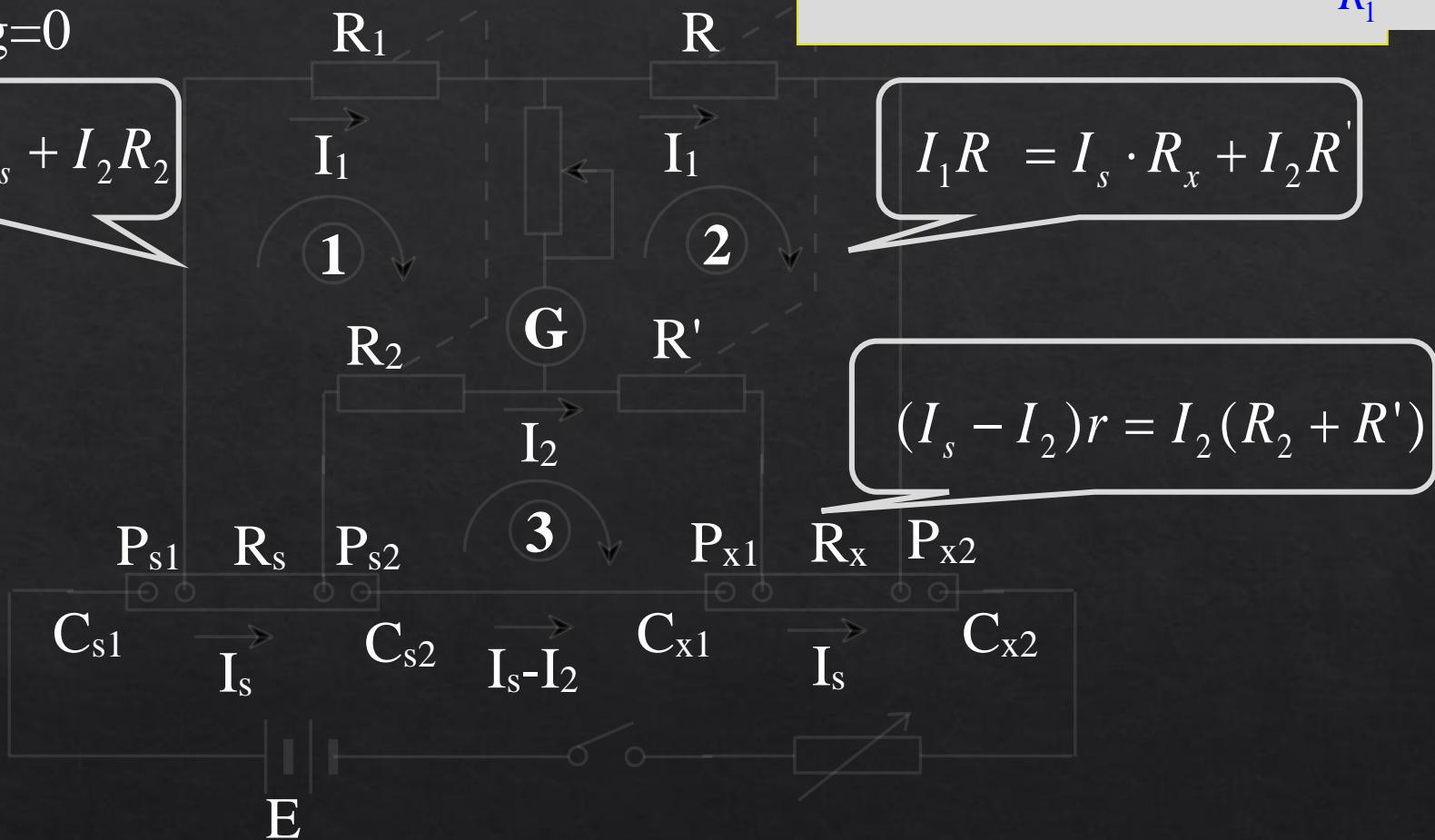


**low resistance R_x ->two Current contact C-C, two Voltage contact P-P.
Four Probe Method**

- measuring low resistance using double bridge


If $I_g=0$

$$I_1 R_1 = I_s \cdot R_s + I_2 R_2$$



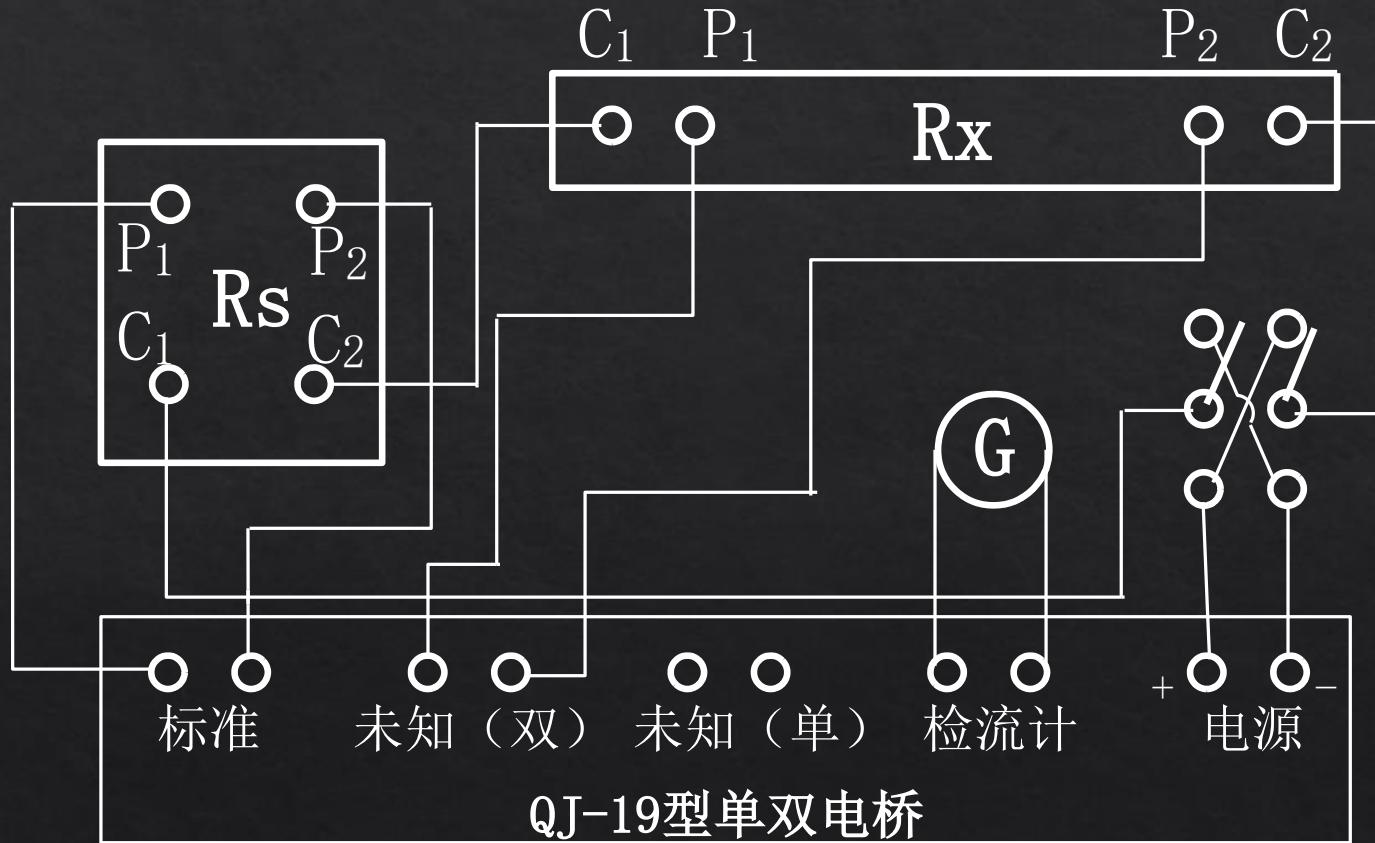
$$R_x = \frac{R}{R_1} R_s + \frac{r \cdot R_2}{r + R' + R_2} \left(\frac{R}{R_1} - \frac{R'}{R_2} \right)$$

Experimental Instruments




➤ Operation

1. Circuit diagram



Circuit



2. Initial adjustment

◆ adjustment of double bridge

R₁, R₂—>10⁴ Ω

Press fine adjustment button (细调)



Switch—》 “double bridge” (双桥)

◆ adjustment of galvanometer

Galvanometer
switch gear-> “zero-
adjustment (调零) ” ,turn the
zero-adjustment
knob to adjust



After zero-
adjustment,
switch gear->
maximum
range “30mV”

◆ How to choose standard resistance

For 200 mm, standard resistance **Rs** -> “**0.01Ω** ” ;

For 400 mm, standard resistance **Rs** -> “**0.1Ω** ”.

◆ adjustment of resistance

By adjusting the sliding side to select resistance's length to be measured , choose two types of length (200mm, 400mm)to measure.



Just measure copper rod!

Notes: to ensure good contact with metal rods, tightening knobs during experiment.

3. Measurements (take 200mm copper rod as an example)

- ① insert copper bar at four terminal resistance box, adjusting the sliding side to 200mm.
- ② After zero-adjustment, switch gear-> maximum range “10mV”
- ③ Turn off reversing switch, adjust double bridge, Make the galvanometer indicated as **zero**, adjust double bridge.
- ④ Adjust the galvanometer to “3mV” , adjust double bridge once more, make the galvanometer indicated as zero. Adjust gradually until galvanometer-> “ $30\mu V$ ” , Balance indicator->0. Record R resistance of double bridge .
- ⑤ Turn the reversing switch to the other side, backward current, adjust bridge balance once more according to ③ 、 ④, record R.

Table I: Diameters of the copper rod

NO.	1	2	3	4	5	Average
d (mm)						

Table II: Resistance and resistivity R1=R2=10000 Ω

	L (mm)	R _S	R		\bar{R}	R _X	ρ	$\bar{\rho}$
			+	-				
Copper rod	200	0.01						
	400	0.1						

$$R_x = \frac{R}{R_1} R_s;$$

$\rho = \pi d^2 R_x / 4L$, d : diameter of copper rod, L : length of rod (200mm, 400mm) ;

$$U_\rho = \rho \cdot \sqrt{\left(\frac{U_{R_x}}{R_x}\right)^2 + 4\left(\frac{U_d}{d}\right)^2 + \left(\frac{U_L}{L}\right)^2}; \frac{U_{R_x}}{R_x} = 0.005, U_L = 1mm,$$

$$U_d = \sqrt{U_A^2 + U_B^2}, U_A = s \cdot \frac{t}{\sqrt{n}}, U_B = 0.004mm, \left(\frac{t}{\sqrt{n}}\right) = 1.24, s = \sqrt{\frac{\sum (d_i - \bar{d})^2}{n-1}}, n = 5$$

END