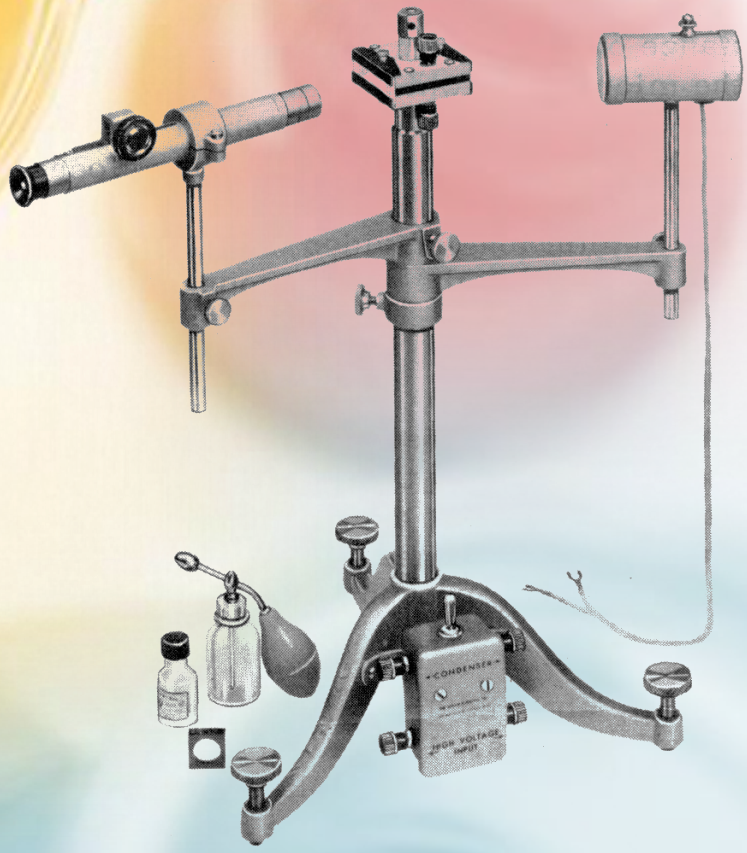

AULA 3

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OBJETIVOS

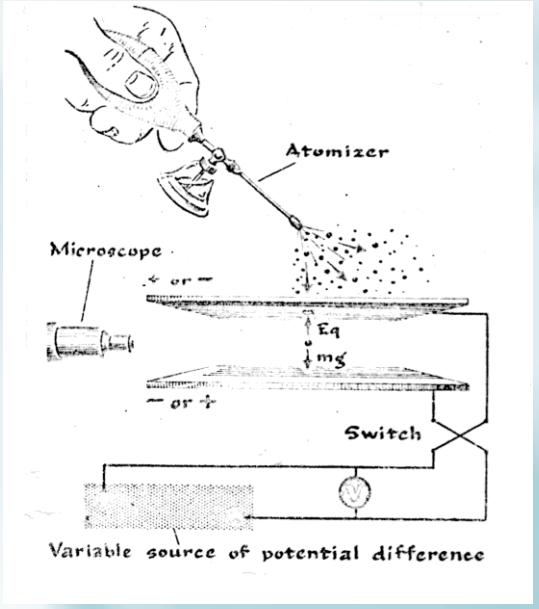
Verificar a natureza quântica da carga elétrica

Determinar a carga do elétron

Analisar o método de medida

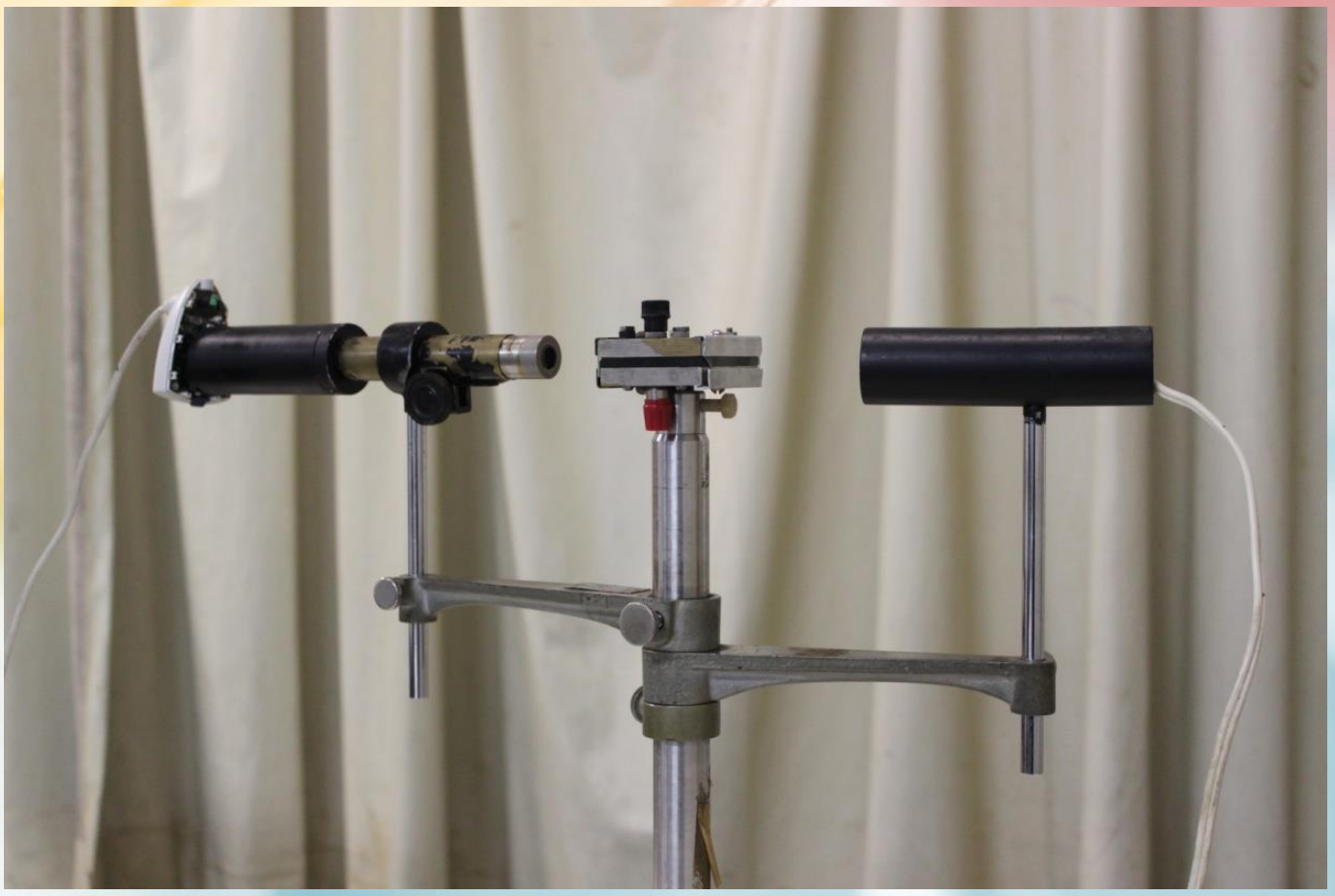
Identificar os fatores experimentais que interferem na experiência

Aula 1 – Procedimento experimental
Tomada de dados
Aula 2 – Análise de dados (incertezas)
Tomada de dados
Aula 3 – Artigo científico (relatório)
Análise dos dados
Finalização da tomada de dados



O EXPERIMENTO

Observação do movimento de gotas de óleo sob a influência de um campo elétrico

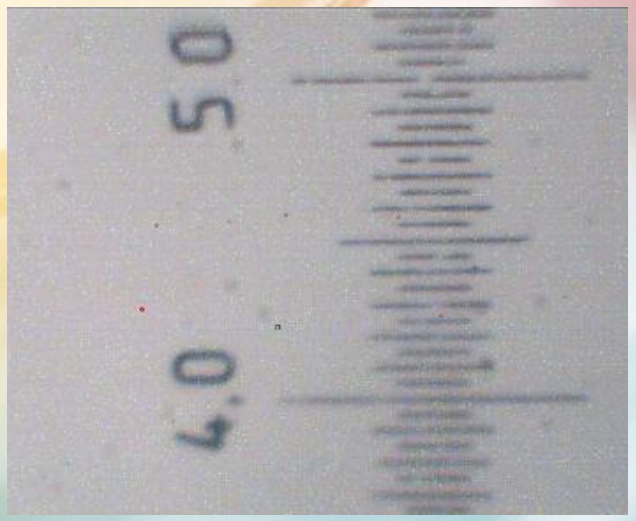


ANÁLISE DAS TRAJETÓRIAS

Programa VideoPoint 2.5

Programa Tracker - http://www.cabrillo.edu/~dbrown/tracker/

Usar a imagem do padrão feita com o programa webcam control para transformar a velocidade em mm/s



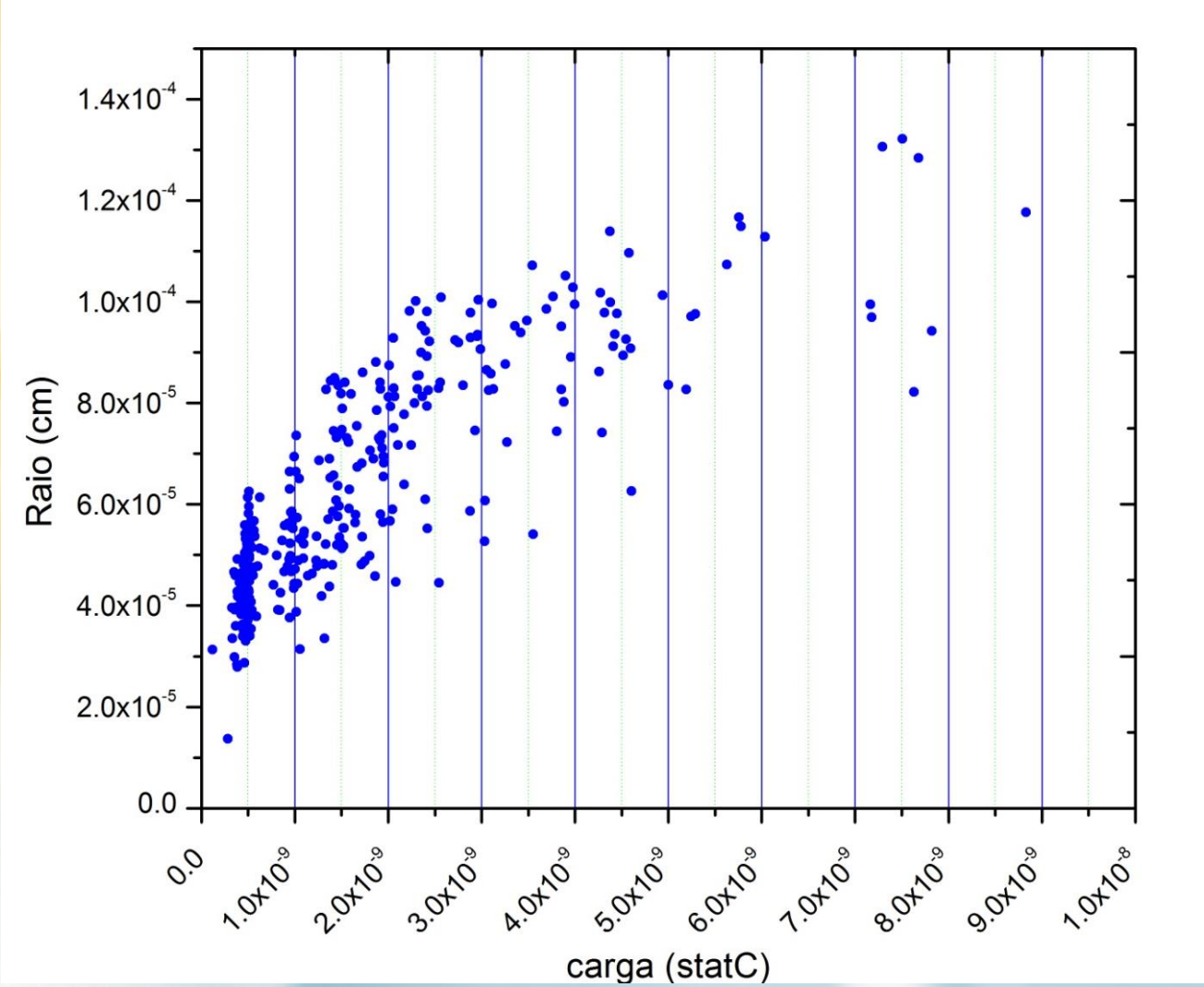
- **Fazer o cálculo de todas as gotas (carga e raio) para entregar o ARTIGO a semana que vem.**

- Enviar ao professor um arquivo Excel com as seguintes informações, em colunas diferentes:
  tensão aplicada, L(cm), L(pix), V_s e V_d em pixels/seg, além de P, T e umidade

EXEMPLO DO ARQUIVO DE DADOS

Gotas	Vd (pixels p/ s)	Vs (pixels p/ s)	1 mm em pixels	Ddp (V)	distância entre placas (cm)
Gota 1:	71,78	26,99	456	289	0,472
Gota 2:	48,83	14,32	456	289	0,472
Gota 3:	45,71	6,50	456	289	0,472
Gota 4:	68,55	37,49	456	289	0,472
Gota 5:	87,46	26,23	456	284	0,472
Gota 6:	86,80	32,79	456	284	0,472
Gota 7:	45,38	18,23	456	289	0,472
Gota 8:	71,10	27,38	456	289	0,472
Gota 9:	70,36	30,00	456	289	0,472
Gota 10:	67,41	23,94	456	289	0,472
Gota 11:	45,31	16,36	456	289	0,472
Gota 12:	89,90	48,91	456	289	0,472
Gota 13:	45,19	9,79	456	289	0,472
Gota 14:	73,90	33,40	456	289	0,472
Gota 15:	68,20	19,90	456	289	0,472
Gota 16:	95,80	47,70	456	289	0,472
Gota 17:	42,50	22,20	456	289	0,472
Gota 18:	68,70	16,60	456	289	0,472
Gota 19:	73,20	21,90	456	289	0,472
Gota 20:	73,60	35,40	456	289	0,472

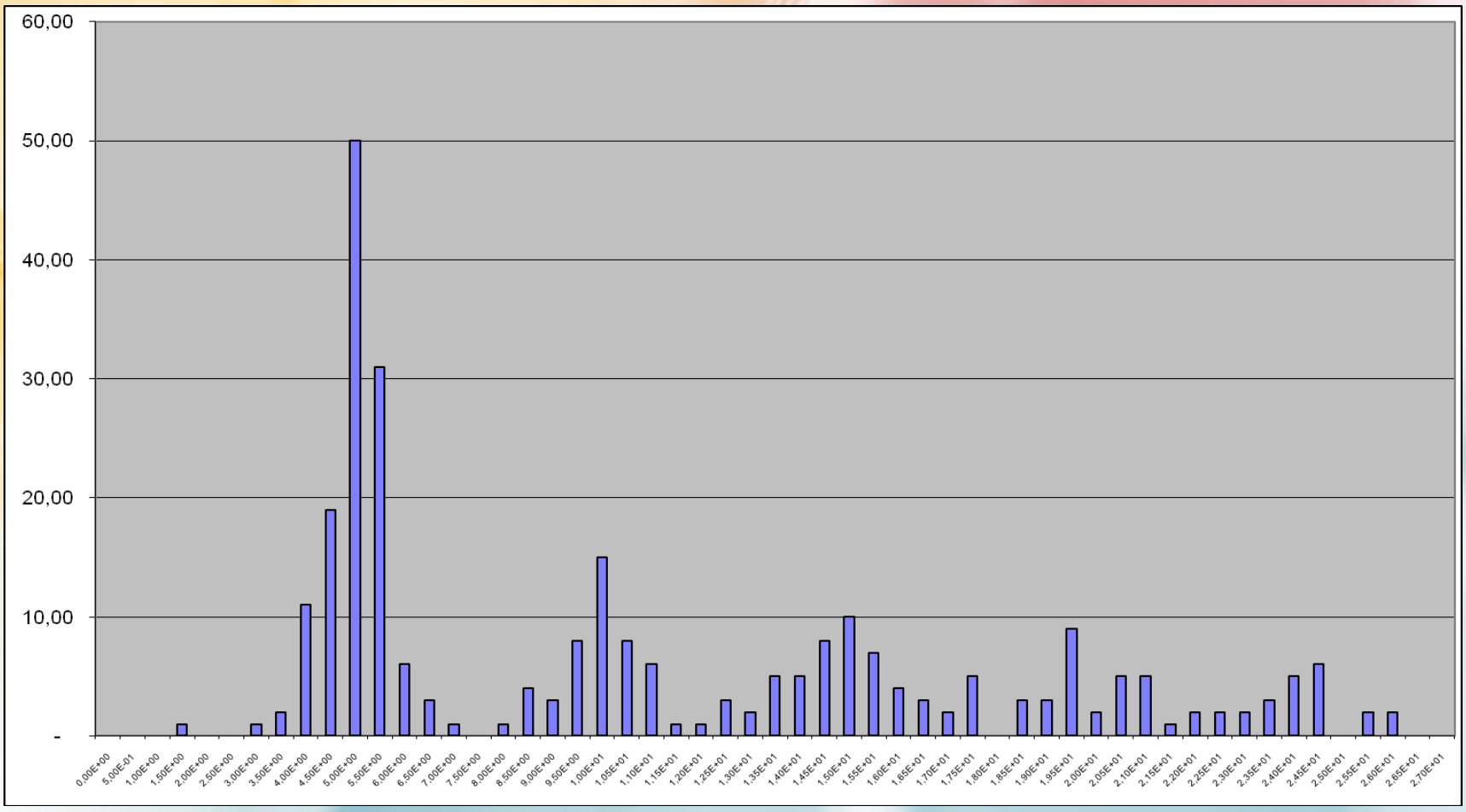
CARGA EM FUNÇÃO DO RAIO DA GOTA



$q = 1{,}602 \times 10^{-19}$ C

$q = 4{,}803 \times 10^{-10}$ statC

HISTOGRAMA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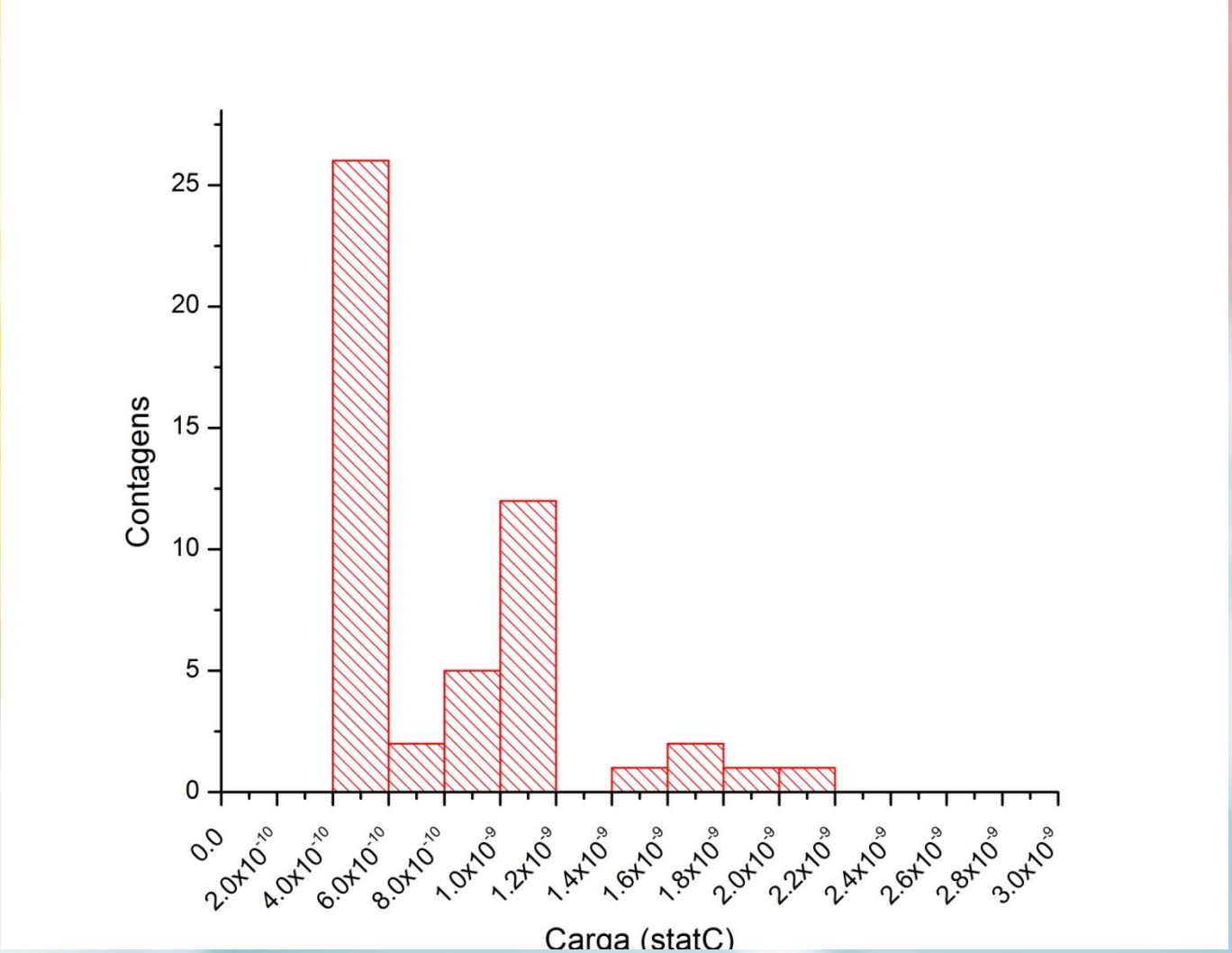
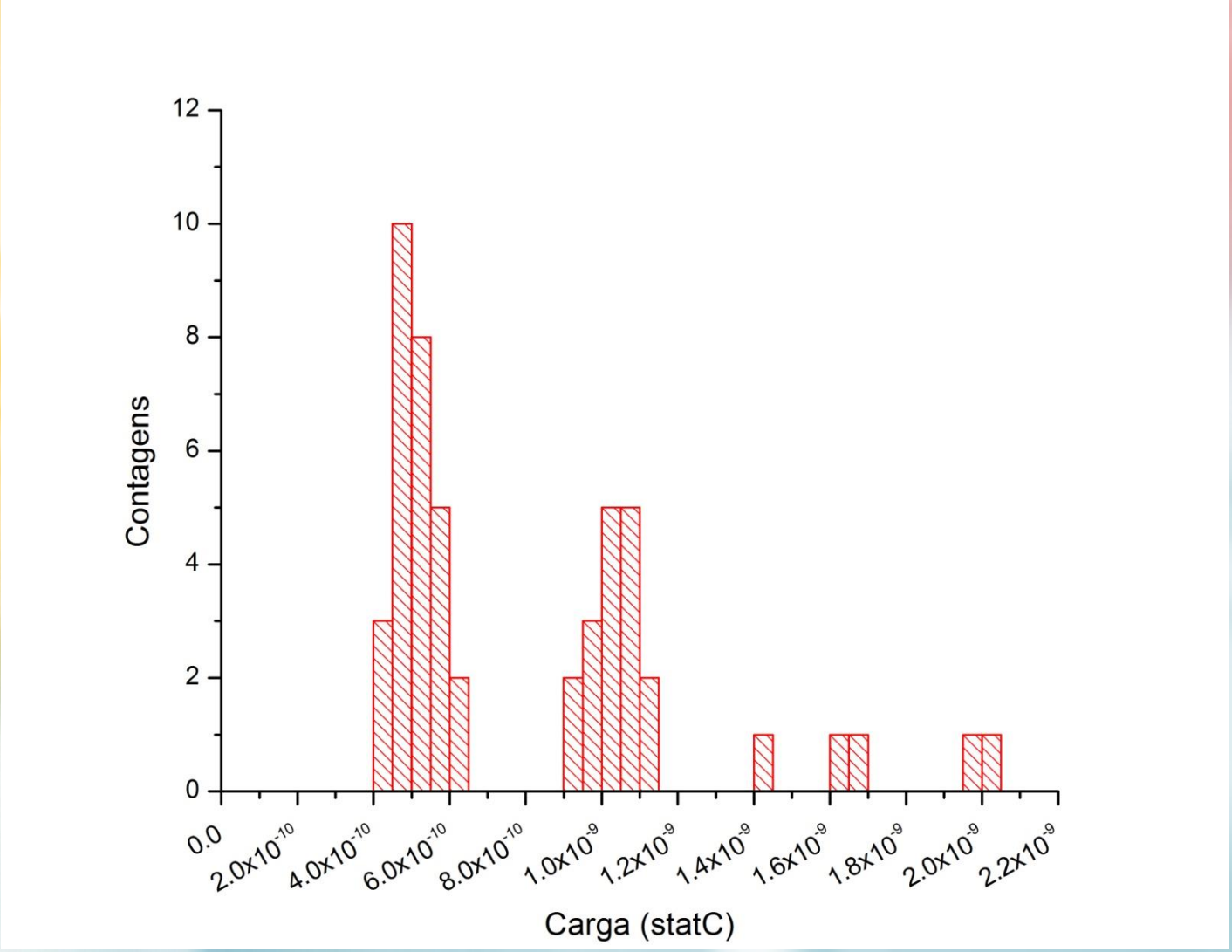
2,40E+01
2,45E+01
2,50E+01
2,55E+01
2,60E+01
2,65E+01
2,70E+01
Carga (10^{-10} statC)

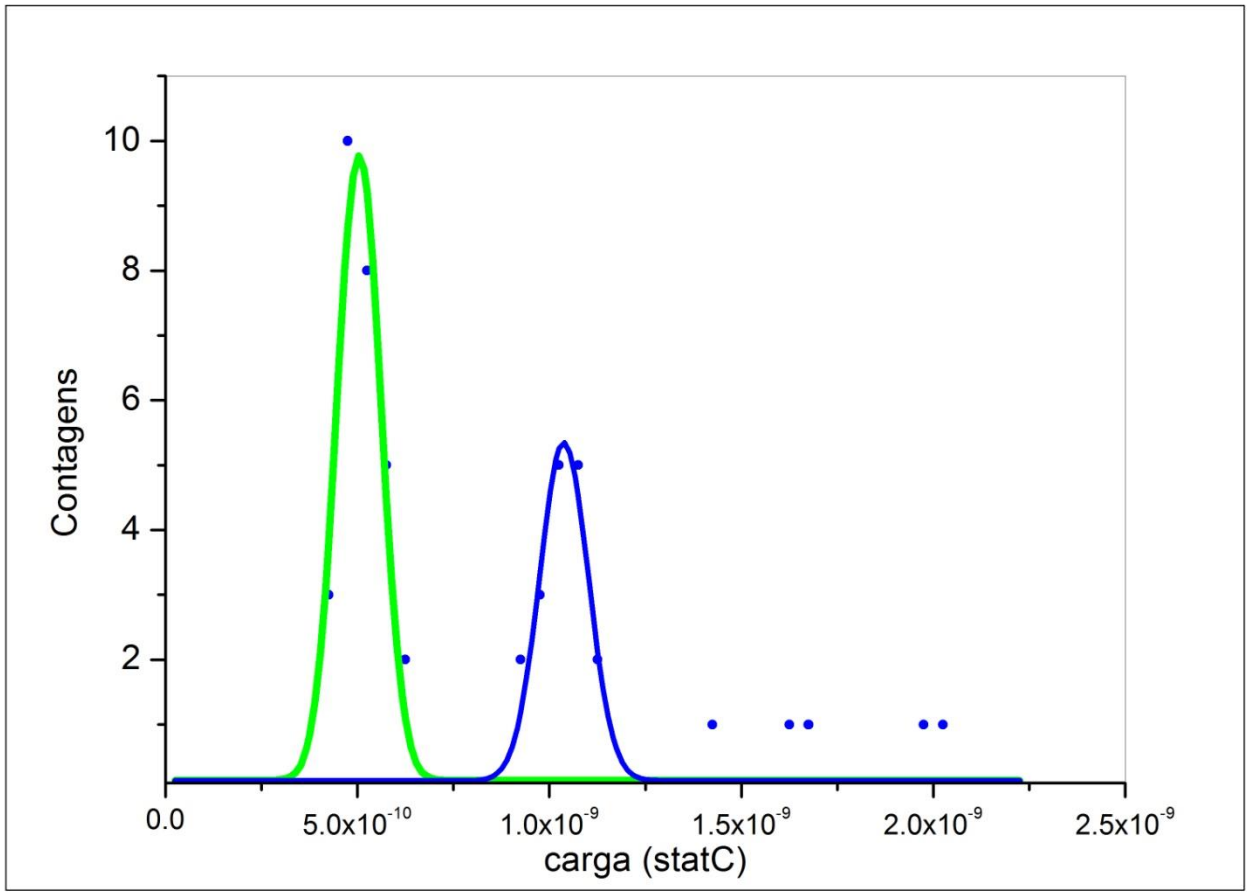
ESTUDO DA QUANTIZAÇÃO DA CARGA



ESCOLHA MAIS APROPRIADA DO INTERVALO



ANÁLISE DE DADOS



$$\bar{q} = q_{cent} \pm \frac{\sigma}{\sqrt{N}}$$

SUGESTÕES

- Estudo do processo de ionização da gota de óleo

Processo de superfície ou de volume ?

Papel di-log

Não é necessário considerar gotas com $n \geq 6$

FORMATO DE ARTIGO CIENTÍFICO

PHYSICAL REVIEW D VOLUME 53, NUMBER 11 1 JUNE 1996

Improved search for elementary particles with fractional electric charge

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(Received 27 December 1995)

We have devised and demonstrated the successful operation of a low-cost, high-mass throughput technique capable of performing bulk matter searches for fractionally charged particles based on an improved Millikan liquid drop method. The method uses a stroboscopic lamp and a charge coupled device video camera to image the trajectories of silicone oil drops falling through air in the presence of a vertical, alternating electric field. The images of the trajectories are computer processed in real time, the electric charge on a drop being measured with an rms error of 0.025 of an electron charge. This error is dominated by Brownian motion. In the first use of this method, we have looked at 5 974 941 drops and found no evidence for fractional charges in 1.07 mg of oil. With 95% confidence, the concentration of isolated quarks with $\pm 1/3e$ or $\pm 2/3e$ in silicone oil is less than one per 2.14×10^{20} nucleons. [S0556-2821(96)00411-0]

PACS number(s): 14.65.−q, 06.20.Jr, 07.50.Yd

I. INTRODUCTION

We have conducted a search for elementary particles with fractional electric charge in silicone oil using an improved Millikan liquid drop method in which we automatically measure the charge on individual drops of about 7 μm in diameter. We have searched through 1.07 mg of oil and found no drops that contained a fractionally charged particle with $\pm\frac{1}{3}$ or $\pm\frac{2}{3}$ of an electron charge. Therefore, with 95% confidence the concentration of isolated quarks with these charges in silicone oil is less than one per 2.14×10^{20} nucleons.

There has been much speculation but no confirmed evidence for the existence of isolated elementary particles with fractional electric charge. The most commonly proposed candidate for such a particle is an isolated quark that would have charge $\pm\frac{1}{3}e$ or $\pm\frac{2}{3}e$, where e is the magnitude of the electric charge of the electron. In this experiment, drops are produced with a nominal charge of $0e$, $\pm1e$, $\pm2e$,.... In the early part of the experiment, drops were produced with charges as large as $\pm10e$, but in the remainder of the experiment, the drops were generally either neutral or had charges of $\pm1e$, $\pm2e$, or $\pm3e$. The sensitivity of the experiment for an anomalous charge decreases when Q, the net electric charge on the drop, is close to Ne, N being an integer. Therefore, our conclusions are limited to the charge regions

$$0.2e \text{ to } 0.8e,\ 1.2e \text{ to } 1.8e,\ 2.2e \text{ to } 2.8e\ldots$$
$$-0.2e \text{ to } -0.8e,\ -1.2e \text{ to } -1.8e,$$
$$-2.2e \text{ to } -2.8e,\ldots . \quad (1)$$

Our method is built upon the technique developed in fractional charge searches at San Francisco State University [1–4] and goes back to the original work of Millikan [5–7]. As shown schematically in Fig. 1, the mechanical part of the apparatus consists of two flat, circular, stainless-steel plates separated by a distance small compared with the plate diameter, the ratio being on the order of 1:16. A device called a dropper produces on demand a spherical drop of silicone oil whose diameter is between 7 and 8 μm. Early in the experiment, we produced drops that were 7.6 μm in diameter. But 94% of the drops studied had a diameter of 7.1 μm. The data presented in the paper is for both sizes, but for simplicity, the remainder of the discussion refers to the 7.1 μm drops.

The drops fall vertically through a small hole in the upper plate, through the space between the plates, and then leave

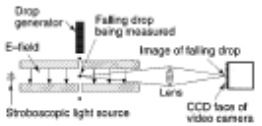

FIG. 1. Schematic of the fractional charge search apparatus. Drawing is not to scale.

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Máximo de 7 páginas

Apresentação dos resultados com algarismos significativos corretos.

$$\bar{q} = 4{,}93(12)x10^{-10}statC$$

ARTIGO CIENTÍFICO (RELATÓRIO)

Título (criativo).

O experimento não deve ser encarado como uma repetição do experimento de Millikan, mas como um trabalho inédito. (Carga elementar)

Nome dos autores e afiliação/Instituição

(1,0) **Resumo** (itálico)

O que foi feito? Como foi feito? Principais resultados e conclusão.

Duas colunas

(1,5) **Introdução** e Teoria: Aspectos gerais, histórico, situar o problema, apresentar as fórmulas a serem utilizadas, **objetivos.**

(2,0) Parte Experimental (**Materiais e Métodos**)

Descrever o experimento, os equipamentos, os cuidados tomados durante a aquisição de dados. Escolha das gotas, etc.

(2,5) **Análise de dados e Resultados**

Gráfico V_{subida} X $V_{descida}$. Histograma das cargas. Verificação da quantização. Correções.

Gráfico $<q>$ em função do número de cargas $\longrightarrow$ Determinação da carga elementar.

Discutir sobre "todas"as incertezas. Apresentar os critérios para o ajuste das gaussianas e as regiões de cada ajuste.

Estudo da ionização da carga (gráfico da carga em função do raio da gota).

(2,0) **Discussão.**

Discutir o procedimento experimental, a análise de dados, os critérios utilizados e os valores obtidos pelo seu grupo e também pela análise dos dados da classe.

(1,0) **Conclusão.** Repetitivo, similar ao resumo. Devem ser enfatizados os pontos mais importantes do artigo.

Referências Bibliográficas (utilizadas no texto).

BOM TRABALHO !!