ISSN 0029-3865

MINISTÉRIO DA CIÊNCIA E TECNOLOGIA

CNPq

CBPF

CENTRO BRASILEIRO DE PESQUISAS FÍSICAS

Notas de Física

CBPF-NF-069/88

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1988

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Área de Publicações
Rua Dr. Xavier Sigaud, 150 - 4º andar
22.290 - Rio de Janeiro, RJ
BRASIL

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*Communication to the 4th International Congress on Radiation Physics, São Paulo 3 to 7 October 1988. Proceedings will be published by Nucl. Instr. & Meths.

ABSTRACT

Curves "range x cone length" and "diameter x cone length" are calculated for tracks left by low energy light ions in CR-39. The calculations cover ions from helium to iron and are performed for 6.25 N NaOH at 70°C and a standard etching time but can be easily extended to other etching conditions.

Key-words: Range; Range-energy; CR-39.

INTRODUCTION

It is accepted since long that by measuring residual ranges of charged particles and displaying their values against E/M - the kinetic energy to mass ratio - one obtains different curves according to the values of Z^2/M.

In SSTD etch pit extension along the trajectory will develop up to or beyond residual range according to etching conditions; for a given bath, temperature and etching duration, a sample of ions of different charge to mass ratios will show different cone lengths, only a small fraction of which will have values close to ion's ranges.

This paper is an attempt to put numerical values on parameters accessible to measurement as it might help in setting up experiments where ion's recognition is relevant. Calculations are restricted to CR-39 etched at 70º C, 6.25 N NaOH, but can be extended without difficult to other SSTD and etching conditions.

RELATIONS AMONG KINETIC AND GEOMETRIC PARAMETERS

Geometric parameters are the cone length and any measure of width, the first taken from the original surface before etching and the last one at the interceipt of the surface after etching with the track profile.

In predicting values for those parameters one needs to know $V = V_T/V_B$ for the etching conditions adopted. This

problem has received the attention of many authors [1]-[5]; here we will restrict the calculations to the results of ref. [5] since it deals explicitely with CR-39. The authors there show, for tracks left by low energy light ions in CR-39, that

$$V = a(E/R)^b \qquad (1)$$

where a = 16.651, b = 0.863, E is kinetic energy in MeV and R the residual range in micron.

From (1) one also obtains:

$$h = L/V \qquad (2)$$

where L is the cone length at etching time T, $h = V_B T$.

Curves shown in Figs. 1-3 were obtained by handling equations (1) and (2), with the range-energy relation developed in [6] and our value of $V_B = 2.05 \mp 0.56$ micron/hour. Since equation (1) was obtained for Homalite CR-39 and ours is from Sola Optical Co. Japan, we checked the results by applying equation (2) to alpha tracks from a natural uranium source. Fig. 1 shows the etching time required to have L = R, as function of E/M; Fig. 2 shows L as function of E/M for a standard etching time numerically equals to $1/V_B$; Fig. 3 is the same as Fig. 2 but replacing E/M by range values as independent variable.

DISCUSSION

As Fig. 1 shows, cone length and residual range will be different in most cases, even when one has a sample with just one kind of ion but different velocities.

If velocity is known previously or independently then cone length can be plotted against E/M, displaying different ions along well separated curves. This procedure will call for a filter of velocities in connection with CR-39. We tried a plot of d - the diameter of the small axis in phase 1 of ref. [3]- against residual range, to replace extra information on ion's velocities, but separation of ions look rather poor, as shown in Fig. 4. The same happens to other measurable parameters, not shown in our graphs.

Finally when particles go through several sheets of SSTD and residual range can be measured to within cone length fluctuations tied to etching time, identification of ions can be achieved easily as shown in Fig. 3. This sort of plot was used successfuly with Lexan sheets exposed to heavy primaries in cosmic rays [7]; the authors reputed that behaviour to special properties of Lexan that might also be present in CR-39.

CAPTIONS FOR FIGURES

Fig. 1 - Etching time in hours required to produce cone lengths equal to residual ranges for light ions stopping in a sheet of CR-39, as function of E/M.

Fig. 2 - Cone length as function of E/M, for light ions in CR-39 at etching time $T = 1/V_B$.

Fig. 3 - Cone length as function of residual range for light ions in CR-39, at etching time $T = 1/V_B$.

Fig. 4 - $10(d-1)$ against residual range for ligth ions in CR-39, at etching time $T = 1/V_B$; d is the diameter of the small axis of etch pit developped during phase 1 as described in [3].

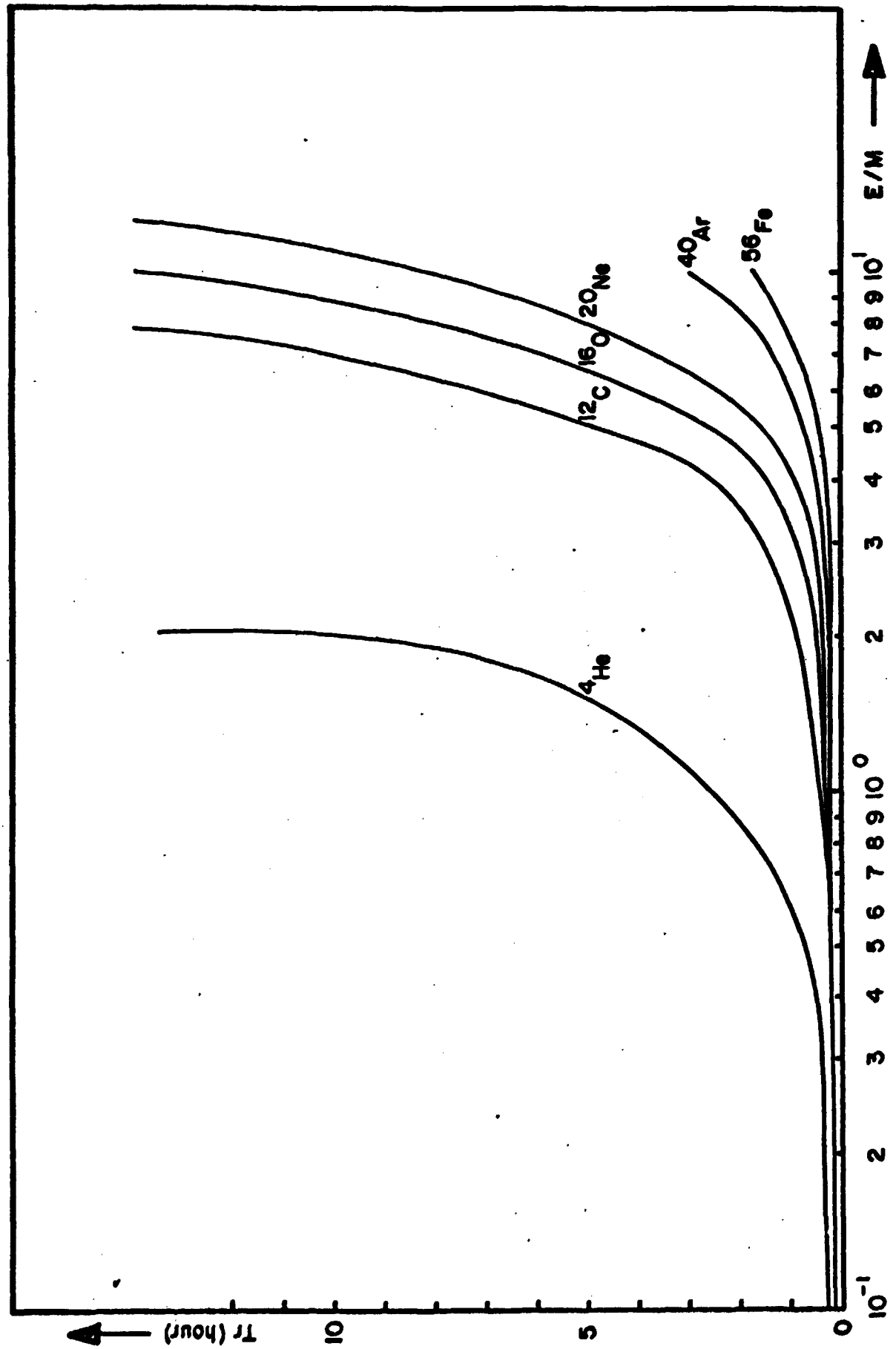
Tr (hour)
10
5
0
10^{-1}
2
3
4
5
6
7
8
9
10^{0}
10^{1}
E/M
^{4}He
^{12}C
^{16}O
^{20}Ne
^{40}Ar
^{56}Fe

Fig. 1

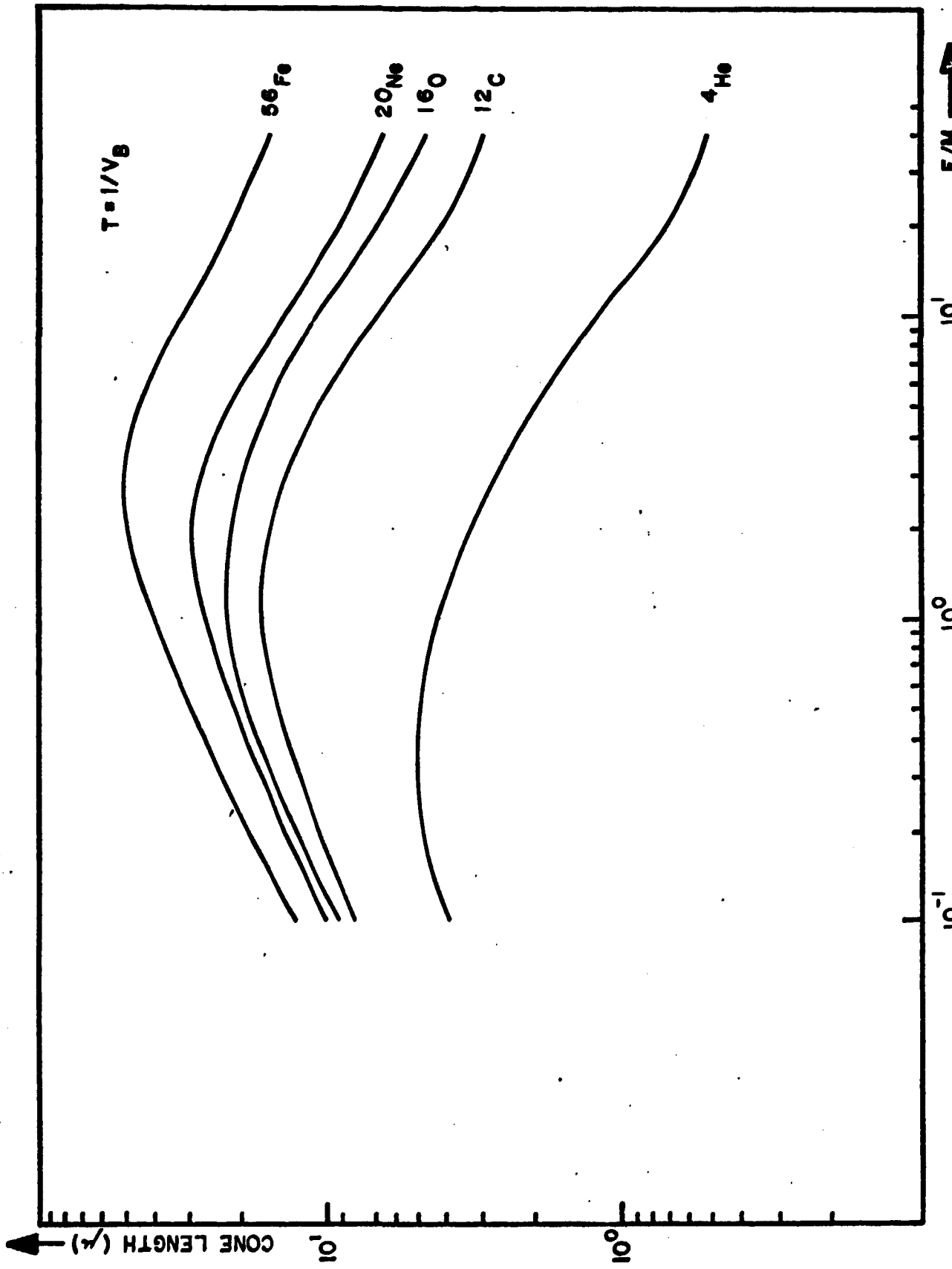

Fig. 2

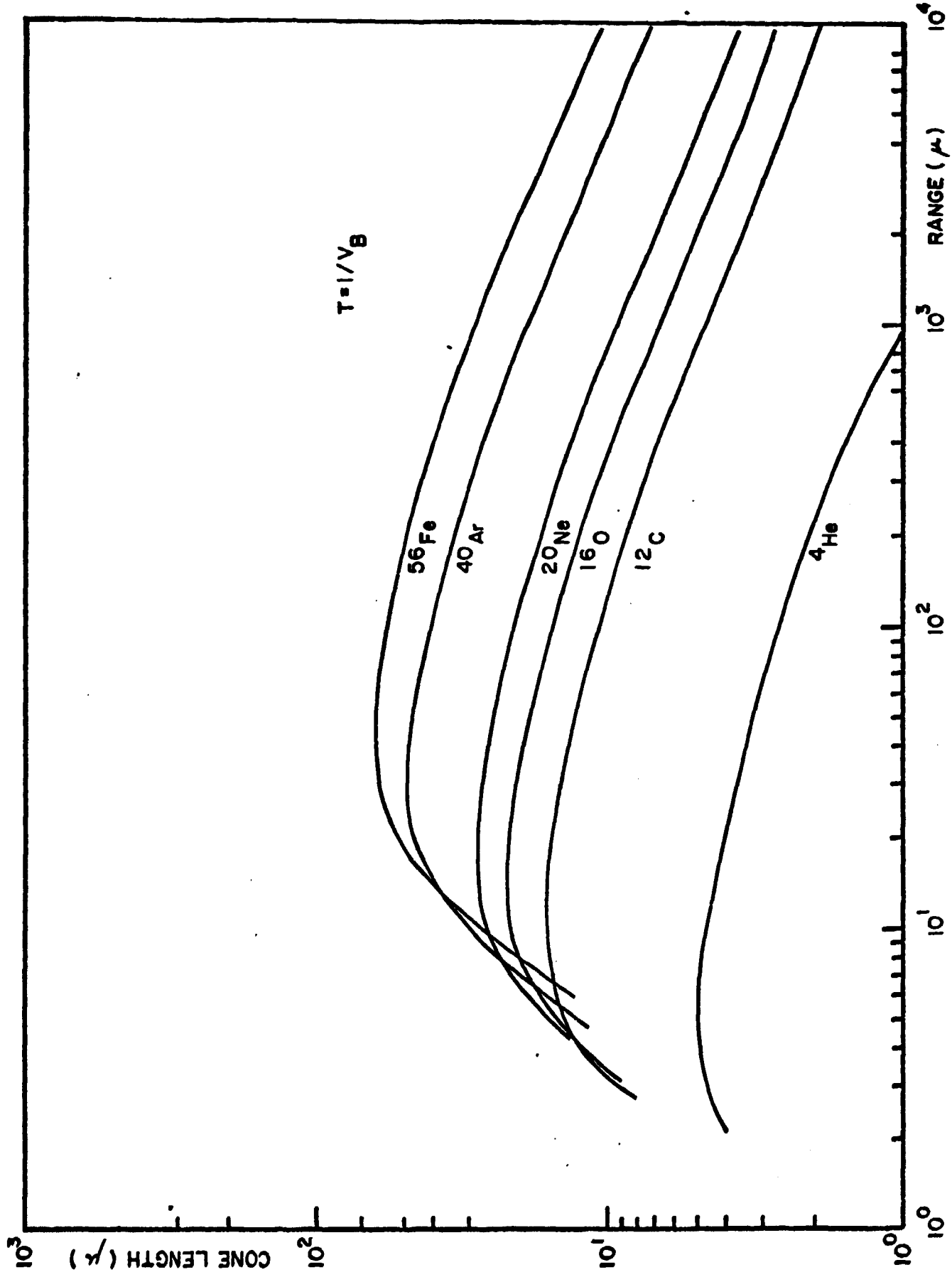
$T = 1/V_B$
^{56}Fe
^{40}Ar
^{20}Ne
^{16}O
^{12}C
^{4}He
RANGE (μ)
CONE LENGTH (μ)
10^0
10^1
10^2
10^3
10^4

Fig. 3

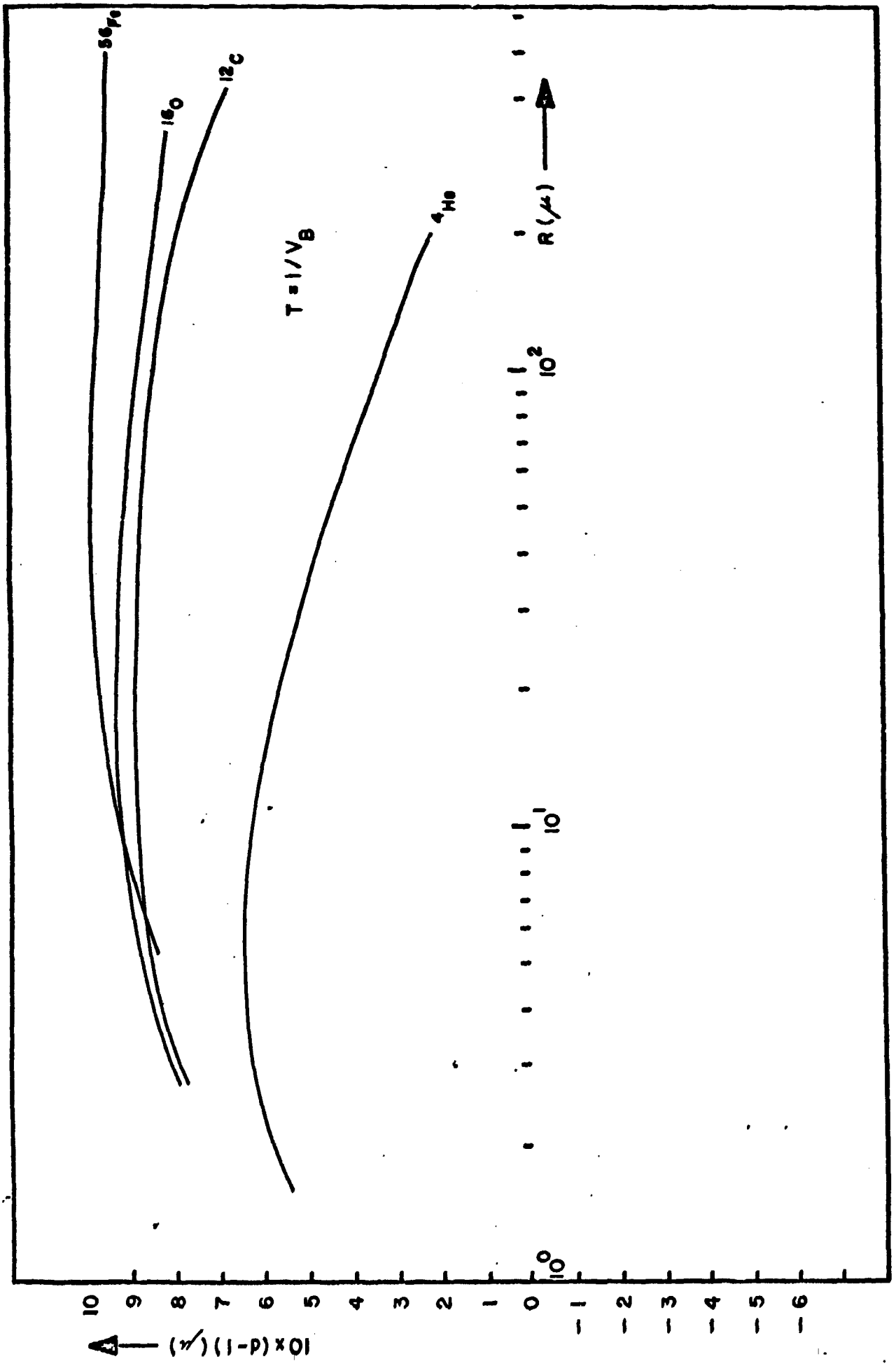
56Fe
16O
12C
4He
T = 1/VB
R (μ)
10^2
10^1
10^0
10 x (d-1) (μ)
10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6

Fig. 4

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