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22 April 1982

Professor R. K. Varma
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Dear Professor Varma:

I wish to apologize to you for the delay in replying to your letter of 24 February. Thank you very much for critical reading of our joint paper titled "Nonadiabatic Particle Motion..." and for suggestion of publication.

In the previous calculation which corresponds to the case (B) in the paper, I noticed that there were some shortcomings and that the range of ϵ^{-1} was narrow. In order to remedy those shortcomings, I decided to calculate in a new configuration of magnetic field (the case (A) in the paper) in the wide range of ϵ^{-1} , and tried to find "multiple life times" in that configuration. Some merits in the new configuration are as follows:

- (i) Because the magnitude of the magnetic field, B , is independent of the radial coordinate r at $z=0$, all the particles distributed on a circle around the guiding center r_{g0} with the same energy and the same pitch angle have exactly the same magnetic moment at $t=0$. Therefore, these particles move along the same trajectory in the adiabatic approximation and can not be distinguished each other in statistical sense. In the old configuration (the case (B)), on the other hand, $B(z=0)$ depends on r , and the particles distributed on a circle have their magnetic moment slightly different from each other.
- (ii) The quantity $2\pi r_{g0}/L$ (≈ 0.31) is much less than unity in the case (A) and $\mu_0 - \mu_c$ is relatively large, then the WKB approximation for multiple life times is good (In the case (B), $2\pi r_{g0}/L \approx 1.11$ and $\mu_0 - \mu_c$ is smaller).

- (iii) The smallness of r_{g0}/L was used in the calculation of the stability parameter S in both the cases (A) and (B), so the approximation in the case (A) is better than in the case (B).
- (iv) The condition for the exact trapping, $r < r_s$: the Störmer radius, can be rigorously derived in the case (A).
- (v) The CPU-time of the computer calculation in this configuration is much shorter than in the case (B) where the modified Bessel functions are used.

List of the numerical results under separate cover

Case (A) Simple cylinder: $A_\theta = \frac{r}{2} \Omega_0 [1 - \text{acos}(\frac{2\pi z}{L})]$ (\rightarrow eq. (4) in the paper)

(A-1) (Escaping time vs. Initial gyrophase ϕ_0) plots
Two kinds of graphs for each $\epsilon^{-1} = \eta$

{ points
histograms...the tops coincide with the points

(A-2) Life times (numerical values) and $(\ln(N) \text{ vs. } t)$ plots

(A-3) Life times (graphs)

{ points and lines ...computational calculation
with error bars
solid lines...the WKB approximation
broken lines...cosh⁻²-profile approximation

(A-4) { Diffusion coefficient (by Chirikov's picture)
Stability parameter S
The Störmer radius r_s

Case (B) Rotational free field: $A_\theta = \Omega_0 [\frac{r}{2} - \frac{aL}{2\pi} I_1(\frac{2\pi r}{L}) \cos(\frac{2\pi z}{L})]$ (\rightarrow eq.(7))

(B-1) (Escaping time vs. initial gyrophase ϕ_0) plots

(B-2) Life times in the region $AN=6$ through 7

$(\ln(N) \text{ vs. } t)$ plots in the region $AN=5$ through 7

Here, $AN = \frac{2(1-a)\cos\psi_0}{\pi \sin^2\psi_0} \epsilon^{-1}$

($\approx 0.430008\epsilon^{-1}$ and $\cos\psi_0 = 0.57$ in this case)

Relation between your questions in your letter of 24 February
and the numerical results

Your question

Numerical result

1

(B-1)

2

(B-2)

Life time is expressed in the WKB approxima-
tion by

$$\ln \tau_n = A + \ln \eta + B \eta ,$$

with constants A and B. Because of the
first and the second terms, the slopes of
two life times $n=1$ and $n=2$ are not given
by the simple ratio 1:2.

PS-1

(A-2)

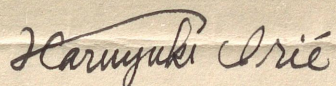
PS-2

(A-3)

The diffusion coefficient (involving some approximations)
derived from Chirikov's theory is rather smaller than that obtained
from numerical results.

The condition for the exact trapping $r < r_s$ corresponds to
 $\epsilon^{-1} < \epsilon_S^{-1} = 4.390$ in the case (A). I think this behavior is
included in neither Chirikov's theory nor your theory.

Yours sincerely,



Haruyuki Irié