COMMENTS

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Comments on "Toroidal equilibrium of current carrying plasmas"

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(Received 30 August 1974)

In an important paper under the above title[1] Yoshikawa gives a general method for constructing large aspect ratio toroidal equilibria. The point of this note is to show that they are, in fact, more general than the author realizes.

Dr. Yoshikawa finds a particular solution to his Eq. (10) to be

$$U_p(r)=\frac{d\psi_0}{dr}f(r)=\psi_0'(r), \tag{1}$$

$$f(r)=\int_0^r dr'\frac{1}{r'(\psi_0')^2}g(r'), \tag{2}$$

and uses this form to construct his general solution, valid up to first order in the reciprocal aspect ratio. He then goes on to say that the integral usually diverges if $d\psi_0/dr$ becomes zero at some nonzero r and toroidal equilibrium cannot be maintained. In actual fact, $d\psi_0/dr$ having a zero need not stop us from constructing an equilibrium. The point is that (1) is a local relationship. In general, the r interval must be divided up into n subintervals bounded by the zeroes of $d\psi_0/dr$ and

$$U_{p,n}(r)=\frac{d\psi_0}{dr}f_n(r), \tag{3}$$

Eq. (2) only being valid up to the first zero of $d\psi_0/dr$ (other than $r=0$). To illustrate this point take the relationship

$$\sin r=\cos r\int_0^r\frac{dr'}{\cos^2 r'},\quad 0\leq r\leq 2\pi. \tag{4}$$

If one were to treat this formula as being valid everywhere, one would conclude that $\sin r$ is divergent. In fact, one has

$$\cos r\int_0^r dr'/\cos^2 r';\quad 0\leq r\leq \pi/2,$$

$$\sin r=\cos r\left[\int_{\pi/2+\epsilon}^r dr'/\cos^2 r'+tg\left(\frac{\pi}{2}+\epsilon\right)\right];\quad \frac{\pi}{2}+\epsilon\leq r\leq\frac{3\pi}{2},$$

$$\cos r\left[\int_{3\pi/2+\epsilon}^r dr'/\cos^2 r'+tg\left(\frac{3\pi}{2}+\epsilon\right)\right];\quad \frac{3\pi}{2}+\epsilon\leq r\leq 2\pi,$$

and $\sin r$ is by no means divergent. For example see Ref. 4.

Another minor point is that exact solutions of (1) in Yoshikawa's paper are also known for some nonpolynomial k.[2,3]

[1] S. Yoshikawa, Phys. Fluids 17, 178 (1974).
[2] S. Yoshikawa, Phys. Fluids 11, 893 (1968).
[3] E. Infeld, Phys. Fluids 14, 2054 (1971).
[4] E. Infeld, Bull. Acad. Polon. Sci. 23, 3 (1975).

Errata: Simulation of the two-stream convective instability

[Phys. Fluids 17, 1109 (1974)]

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The symbol Δ should be replaced by $\underline{\Delta}$ in all instances on pages 1110, 1111, and 1117.

