Wave breaking of electrostatic waves in warm plasma

Slides from talk by Raoul Trines
@ ICTP Summer College

Full slides are publicly available here:
http://indico.ictp.it/event/a08175/session/113/contribution/80/material/0/0.pdf

Case 1: quasi-static waves

Wave in a homogeneous plasma, only depends on coordinate $\zeta = z - v_\varphi * t$

Cold, non-relativistic: $E_{WB} = v_\varphi$

J.M. Dawson, Phys. Rev. **113**, 383 (1959)

Cold, relativistic: $E_{WB} = \sqrt{2\left(\gamma_\varphi - 1\right)}$

Akhiezer and Polovin, Sov. Phys. JETP **3**, 696 (1956)

Warm, non-relativistic:

$$E_{WB} = v_\varphi \left[1 - 8/3\left(\beta / v_\varphi^2\right)^{1/4}\right]^{1/2}, \quad \beta = 3k_B T / \left(mc^2\right)$$

T.P. Coffey, Phys. Fluids **14**, 1402 (1971)

Warm, relativistic: needs more attention

Case 1: warm, (ultra-)relativistic

Many models for this case, most are invalid.

Relativistic waterbag: $E_{WB} \propto \sqrt{\ln\left(\gamma_\varphi^2 \beta\right)} \Big/ \beta^{1/4}$

- Proper relativistic plasma pressure
- Good correspondence between model breakdown and particle trapping
- Particle trapping handled properly
  - Use of warm-plasma potential to study trapping in warm plasma
  - No separate plasma pressure term in particle Hamiltonian, as it should be
- $E_{WB} \to \infty$ for $\gamma_\varphi \to \infty$, as it should be

Katsouleas and Mori, PRL **61**, 90 (1988)

Trines and Norreys, Phys. Plasmas **13**, 123102 (2006)