B-O2

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Turbulent particle flux suppression by radial electric field non-uniformity at edge transport barrier in JFT-2M tokamak

T. Kobayashi[1], K. Itoh[1,2], T. Ido[1], K. Kamiya[3], S.-I. Itoh[2,4], Y. Miura[3], Y. Nagashima[2,4], A. Fujisawa[2,4], S. Inagaki[2,4], and K. Ida[1,2]

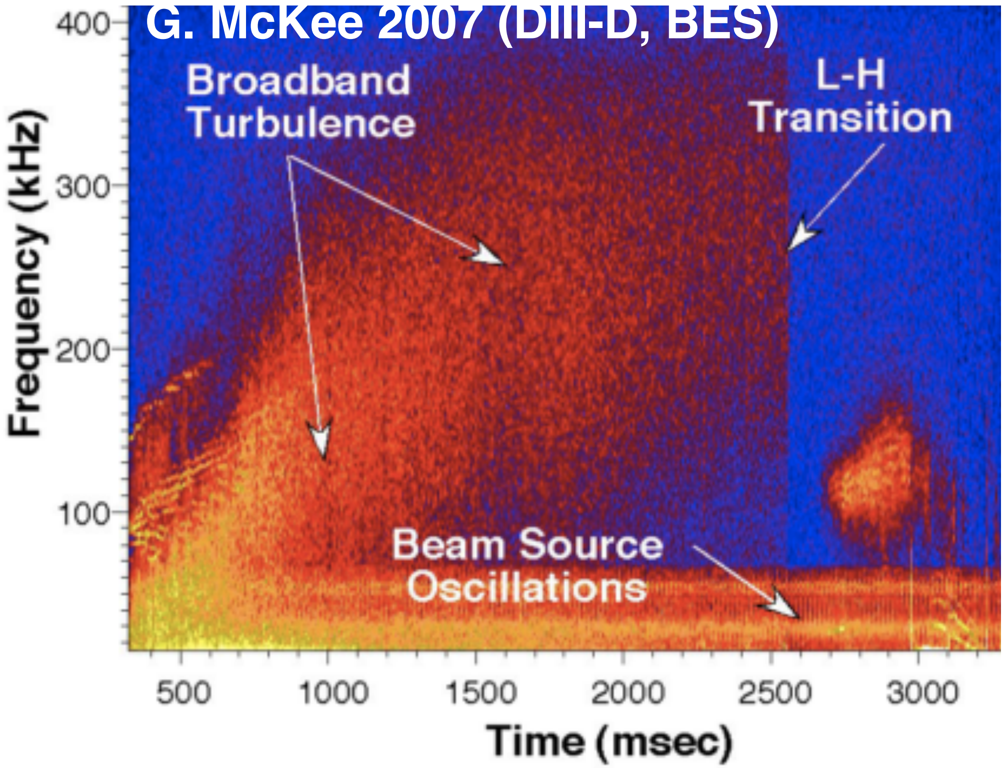
[1]National Institute for Fusion Science
[2]Institute of Science and Technology Research, Chubu University
[3]Research Center for Plasma Turbulence, Kyushu University
[4]National Institutes for Quantum and Radiological Science and Technology
[5]Research Institute for Applied Mechanics, Kyushu University
[6]Japan Atomic Energy Agency

Motivation

- Turbulence transport reduction no doubt occurs in H-mode

- E_r plays a role

Ida 1990, Groebner 1990



- **What** suppresses transport?
- **How** transport is suppressed?

Transport reduction by E_r shear and curvature

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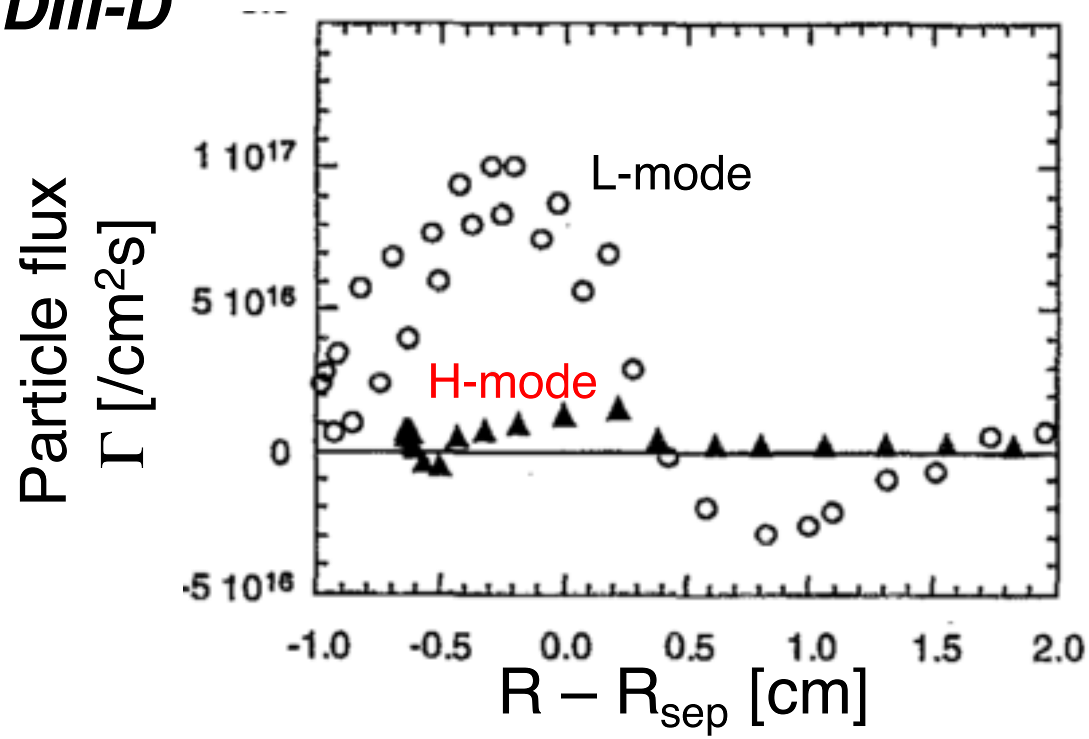


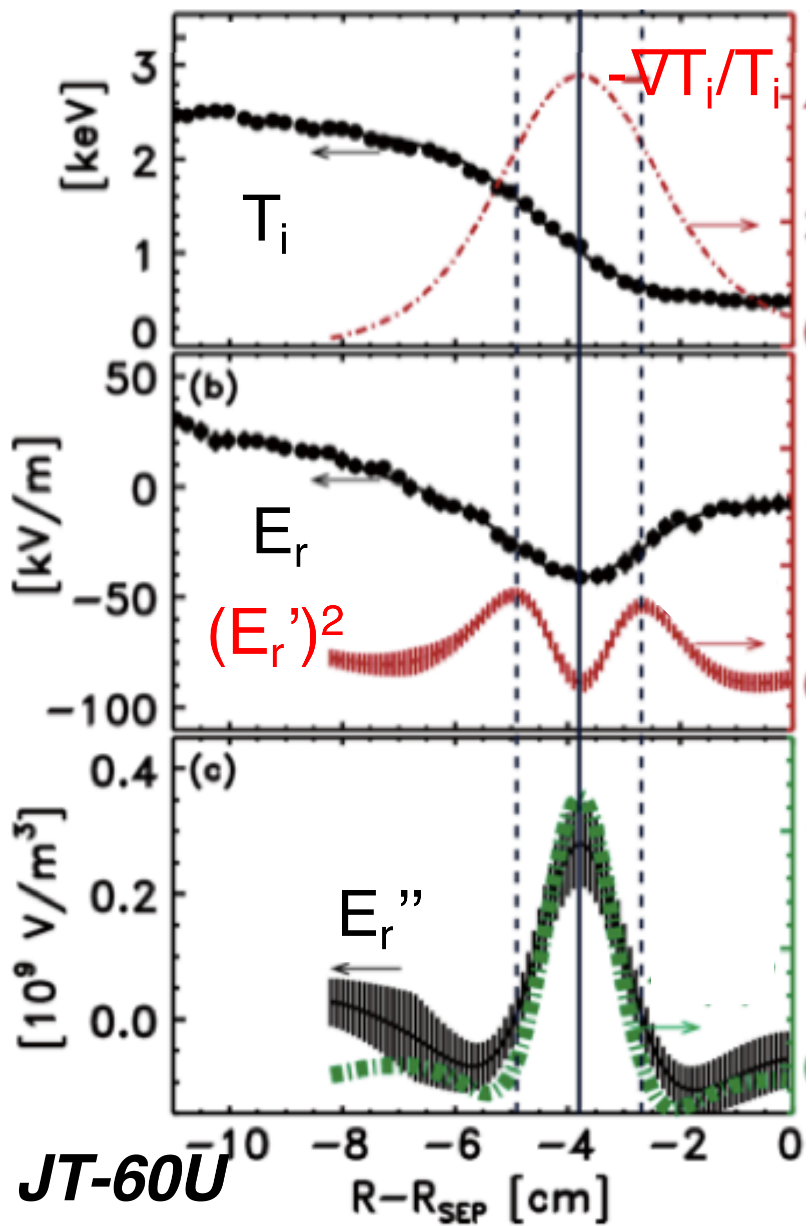
$$\Gamma = B^{-1} k_\theta |\tilde{n}||\tilde{\phi}| \sin(\alpha_{n\phi})$$

- Turbulent transport is reduced though both **amplitude** and **phase**

- Roles of E_r **shear** and E_r **curvature** are discussed.

R. A. Moyer et al., Phys. Plasmas 2 2397 (1995)

A synthetic approach was performed



JT-60U

Amplitude in L-mode

$$I = \frac{1}{1 + (k\rho_i)^{-2}(Z_1 + Z_2)} I_0$$

- **Shear effect** Biglari, Diamond, Terry 1990

$$Z_1 = \rho_i^2 (V_d B)^{-2} E_r'^2$$

- **Curvature effect**

(c.f. Modulational coupling)

Diamond, Itoh, Itoh, Hahm PPCF 2005
Itoh NF 2017

$$Z_2 = \rho_i^2 (V_d B)^{-2} (E_r - V_{tor} B_\theta) E_r''$$

Kamiya et al., Sci. Rep. 6, 30585 (2016)
Kamiya et al., EPS CPP (2017)

Experimental setup

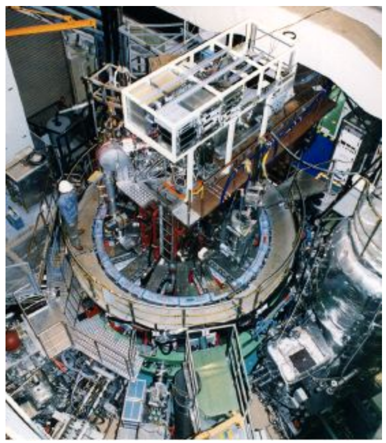
JFT-2M tokamak

R = 1.3 m, a = 0.3 m

B_t = 1.17 T

I_p = 170 kA

q_{95} = 2.9

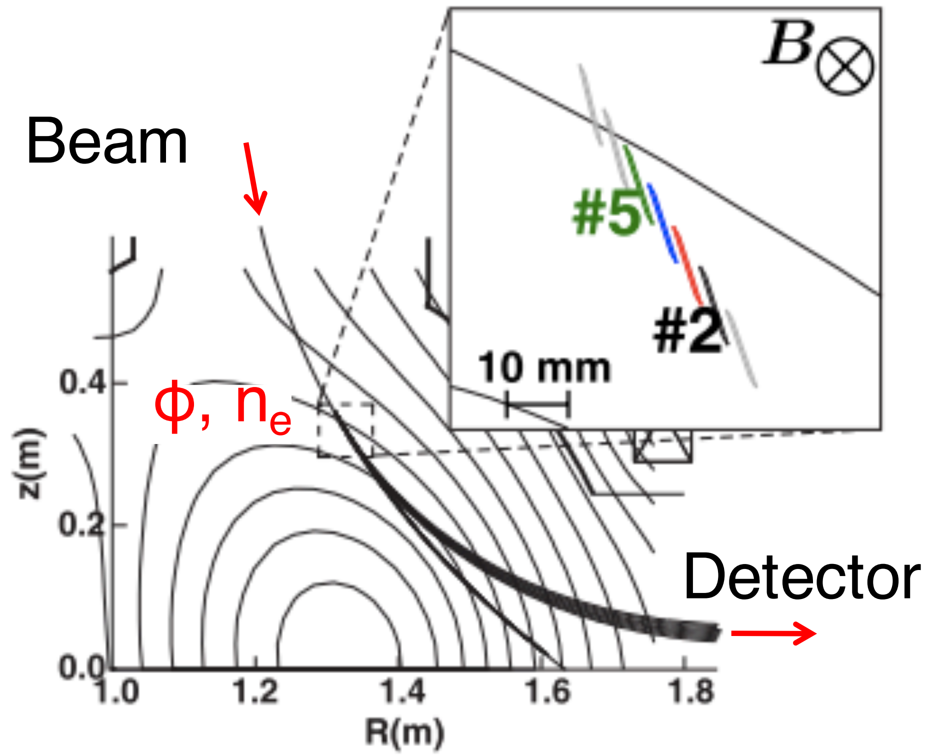


$\bar{n}_e = 1.1 \times 10^{19}$ m^{-3}

NBI power = 750 kW

(Threshold power)

Heavy Ion Beam Probe

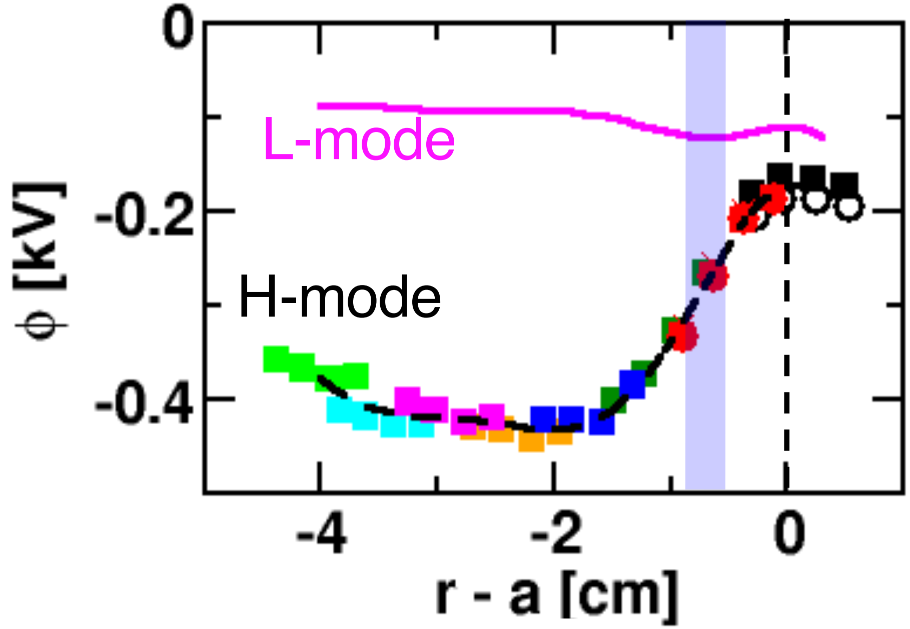


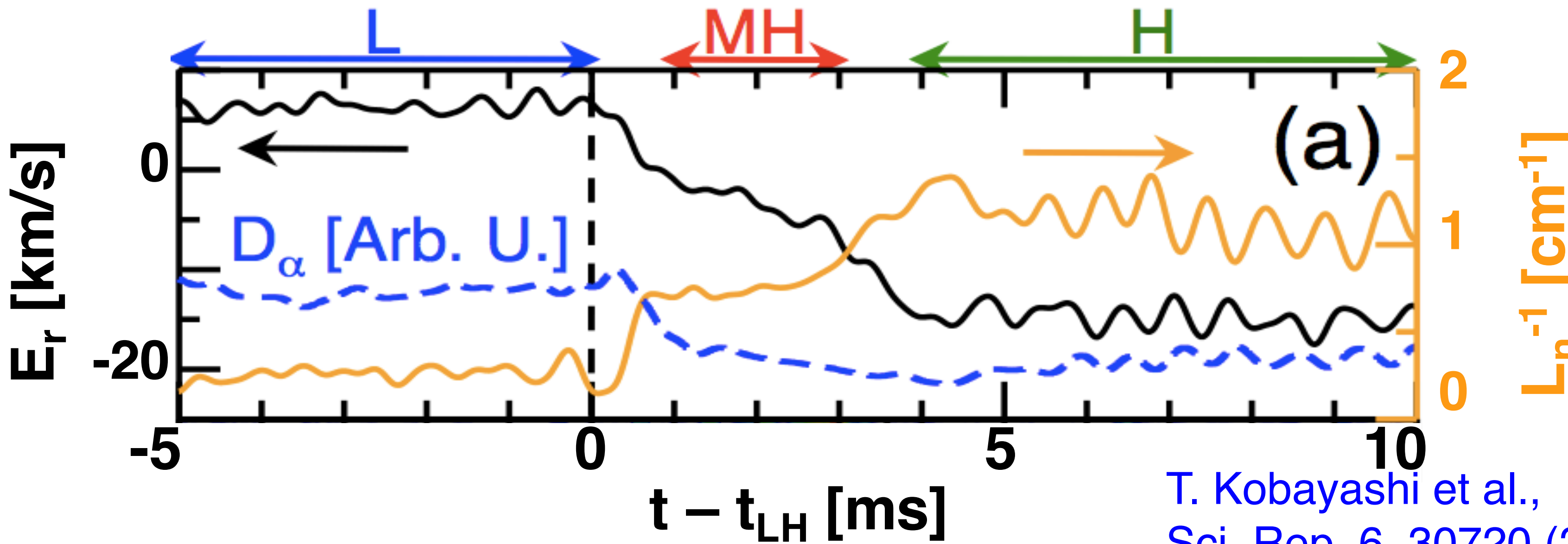
✓ **Potential** and **density** measurement at f < 100 kHz

T. Ido 1999 RSI **70**, 955

L-H transition in JFT-2M

- ETB appears at r-a = -1cm
- Sawtooth triggered transition
- Transition occurs twice





T. Kobayashi et al., Sci. Rep. 6, 30720 (2016)

Responses in Turbulence

- Observation at the E_r-well bottom

- Doppler shift in MH-mode

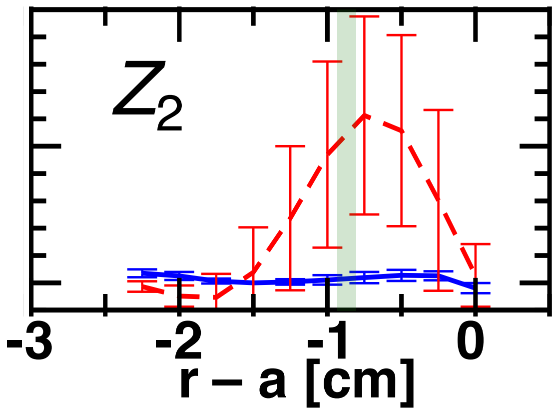
- Amplitude reduction is moderate

- Transport reduction via phase variation

Transport reduction by shear and curvature

Time evolution of amplitude and phase

・Time evolution at r-a=-0.8cm, where Z_2 is large.



・Amplitude immediately responds to Z_2.

・Phase changes in ~1 ms.

・Different physics may exist.

Amplitude and phase as a function of Z_2

- Amplitude suppression is effective when Z_2 (Z_1) is small.

→ A paradigm of transport reduction via amplitude is correct when Z is small.

- Phase approaches zero during the whole change of Z_2.

Summary

- **What** suppresses transport?
- **How** transport is suppressed?

What?

Not only **shear** but also **curvature**

How?

Not only **amplitude** but also **phase**

-Different time scales of changes are found.

T. Kobayashi et al., submitted to Phys. Rev. Lett. (2017)