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#### Fast-Wave Propagation in the Edge of a Cylindrical Cold Plasma under NSTX-like Conditions

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### Significant HHFW power lost <u>directly</u> to divertor regions on NSTX



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- RF power deposited in bright spirals on divertor
- Up to 60% of HHFW missing from core

• IR cameras show up to 2 MW/m<sup>2</sup> heat flux to divertor

- Possibly general to fastwave systems
  - including ITER

### **Outline**

Unexplained observations of HHFW losses in SOL

• The role of the R-cutoff location

• A new tool: a cylindrical cold-plasma model

### HHFW losses in SOL are field-aligned and occur across width of SOL



... resembles spiral pattern seen in camera images



R.J. Perkins et al., Phys. Rev. Lett. 109 (2012) 045001

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# HHFW losses are field-aligned and move as magnetic pitch is changed



- IR camera data available at a single toroidal location
- As magnetic pitch changes, RF spiral moves across lower divertor
  - Field-line mapping prediction tracks motion

#### R.J. Perkins et al., Nucl. Fusion 53 (2013) 083025

### Profile of lost power is large near LCFS as well as antenna

- Midplane profile shows two-peak structure:
  - Peaking close to • antenna and LCFS
  - Relatively low in ۲ between



structure

# Location of righthand cutoff plays crucial role in SOL losses

- Waves have imaginary k<sub>perp</sub> before reaching cutoff
- Large evanescent region can significantly attenuate waves
  - Poor coupling
- On NSTX, moving propagating region too close to antenna promotes SOL losses
  - Poor heating efficiency
- **Goal**: identify optimal density conditions for HHFW operation

### AORSA shows enhanced RF fields in SOL when cutoff layer opens in front of antenna



### N. Bertelli, PI2 (Plaza E), 2:00 PM Wednesday

### **Cylindrical cold-plasma model**



What features can be reproduced using straight magnetic fields and simplified geometry?

- Higher-amplitude fields in annulus
- Field-aligned Poynting flux away from antenna

## m=0 $k_{\phi}$ =13 m<sup>-1</sup> solution shows significant change in annulus fields above and below cutoff



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## Summary

- Unexplained observations of HHFW losses in SOL:
  - across width of SOL
  - field-aligned

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peak near antenna and LCFS

- AORSA shows relationship between SOL losses and the R-cutoff
  - N. Bertelli, PI2 (Plaza E), 2:00 PM Wednesday

 Cylindrical cold-plasma model will complement studies with AORSA