Heat-Flux Measurements from Thomson-Scattering Spectra

2\omega Thomson-scattering spectrum (simulated)

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56th Annual Meeting of the American Physical Society
Division of Plasma Physics
New Orleans, LA
27–31 October 2014
Upcoming experiments on OMEGA will use Thomson-scattering (TS) spectra to measure heat flux in coronal plasmas

- Heat flux in plasmas alters electron distribution functions, which affect Landau damping of ion-acoustic waves (IAW’s) and electron plasma waves (EPW’s)

- Thomson scattering is sensitive to changes in Landau damping and will provide a measurement of heat flux

- Local plasma conditions obtained from Thomson scattering will be used to calculate the Spitzer–Härm (SH) heat flux

- The heat flux obtained from both methods will test the validity of SH in the corona
Collaborators


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The ratio of amplitudes from Thomson-scattered EPW’s will be used to infer heat flux.
The Thomson-scattering volume will be moved along the target normal to measure $Q_{SH}$. Thomson scattering will also be used to measure plasma conditions to determine the heat conductivity and spatial temperature profile.

$3\omega$ drive beams ($\lambda_{3\omega} = 351 \text{ nm}$)

Thomson-scattering volume $50 \mu\text{m} \times 50 \mu\text{m} \times 50 \mu\text{m}$

$\bar{k}_{2\omega}$ ($\lambda_{2\omega} = 526 \text{ nm}$)

$n_e = 1 \times 10^{20} \text{ cm}^{-3}$

$T_e = 1.2 \text{ keV}$

$\nabla T_e$

$Q_{SH} = -\kappa \nabla T_e$

The Thomson-scattering volume will be moved along the target normal to measure $Q_{SH}$. 
The Landau damping of EPW’s is sensitive to the heat flux by introducing a correction term to the electron distribution function.

Maxwellian electron distribution function

First-order SH correction

Landau damping of EPW’s

Thomson scattering makes it possible to probe various phase velocities to measure differences in Landau damping.
Differences in Landau damping result in varying amplitudes of Thomson scattering from IAW’s and EPW’s.

Experiments will measure differences in Thomson-scattered amplitude to infer heat flux.
Simultaneous measurements of the Thomson-scattered amplitudes of EPW and IAW features will be used to infer the heat flux.
Two-dimensional hydrodynamic simulations predict the locations along the target normal that probe the appropriate values of heat flux.
Spitzer-Härm heat flux becomes unphysical for $|f_1| \approx f_0$.

Electron distribution functions

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