Transport of particles and energy in the edge plasma of the
Alcator C-Mod tokamak

by

Maxim Umansky

Submitted to the Department of Physics
on October 5, 1999, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy in Physics

Abstract

In this thesis analysis and numerical modeling of transport in the edge plasma in the
Alcator C-Mod tokamak are presented. Several important results were obtained in
the course of this work, providing a new understanding of some aspects of the physical
picture of the edge plasma in C-Mod. The key finding are:

• Plasma escaping from the core recycles on the main chamber wall rather than in the
divertor. Thus plasma recycling occurs largely independently in the main chamber
and in the divertor chamber.
• The radial particle transport in the scrape-off layer (SOL) is radially non-uniform
with the "effective" anomalous diffusion coefficient $D_a$ growing by more than an order
of magnitude across the SOL.
• Heat flux carried out of the core plasma across the last closed flux surface is in most
cases dominated by radial convection and charge-exchange (CX) neutrals rather than
by anomalous heat diffusion. In certain regimes convection and CX heat conduction
dominate the radial heat transport across the whole SOL.
• The main chamber neutral gas density reflects the level of anomalous particle trans-
port from the core plasma rather than the quality of neutral gas baffling in the div-
ertor.
• The core plasma is fueled by neutrals diffusing into the core mainly through the
lower half of the last closed flux surface.

As these findings touch on the most basic issues in the tokamak edge physics, these
results contribute to our understanding of the tokamak edge plasmas in general,
athough they may not fully apply to other tokamaks.

Thesis Supervisor: Earl S. Marmar
Title: Senior Research Scientist