Inverse Sheath

Igor Kaganovich, Yevgeny Raitses
Princeton Plasma Physics Laboratory

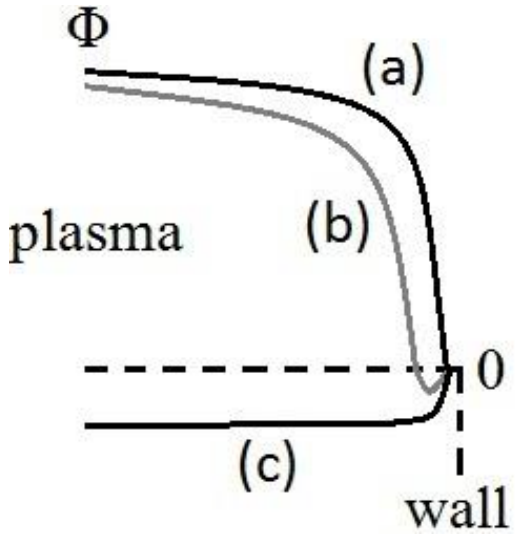
Princeton University ExB Workshop, November 1, 2018

Inverse Sheath

- History
- Recent Observations

Disappearance of Debye Sheaths Due to Secondary Electron Emission

New regime of plasma state when emission from the wall is very intense $\gamma > 1$.



Qualitative differences between the potential profile, relative to the wall, of a classical sheath (a), SCL sheath (b) and the new inverse sheath (c). Note that plasma electrons are still confined by the SCL sheath, but not confined by the inverse sheath.

M. Campanell, A.V. Khrabrov, I.D. Kaganovich, "*Absence of Debye Sheaths Due to Secondary Electron Emission*", Phys Rev Lett., **108**, 255001 (2012).

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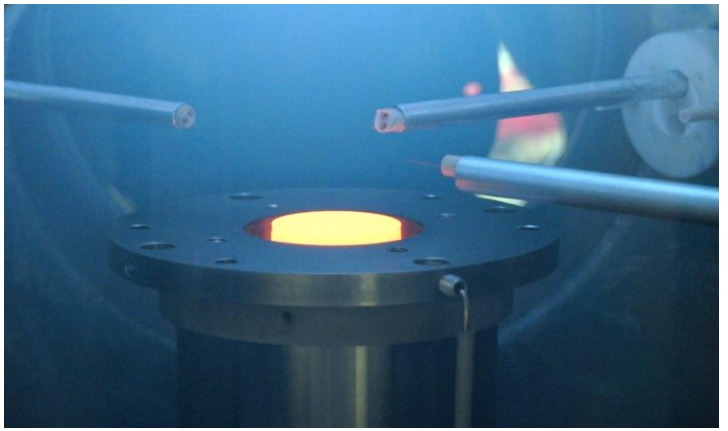
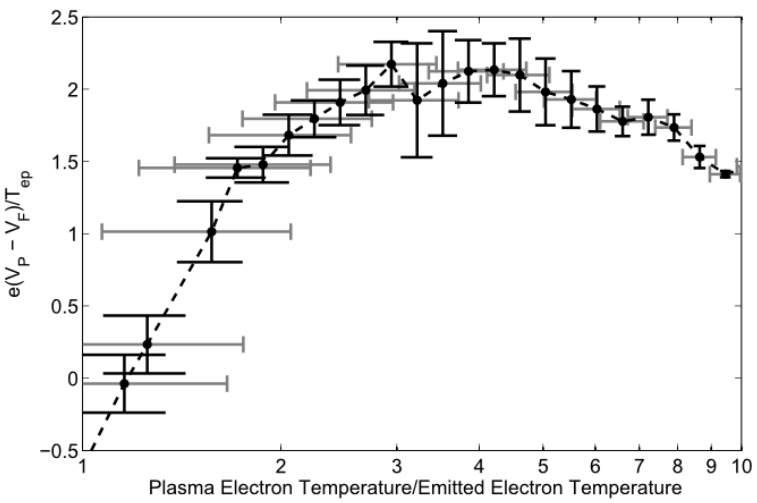
PLASMA POTENTIAL NEAR EMITTING SURFACE IN COMPLEX PLASMAS

JP Sheehan of UWM conducted experiments at Sandia to measure sheath potential between emitting wall and plasma for different plasma temperatures in plasma afterglow.

First validation of theoretical predictions that the sheath potential drop near strongly emitting surface vanishes as plasma temperature approaches temperature of the emitted electrons.





J. P. Sheehan, N. Hershkowitz, I. D. Kaganovich, H. Wang, Y. Raitses, E. V. Barnat, B. R. Weatherford, and D. Sydorenko, "Kinetic Theory of Plasma Sheaths Surrounding Electron-Emitting Surfaces", Phys. Rev. Lett. **111**, 075002 (2013).

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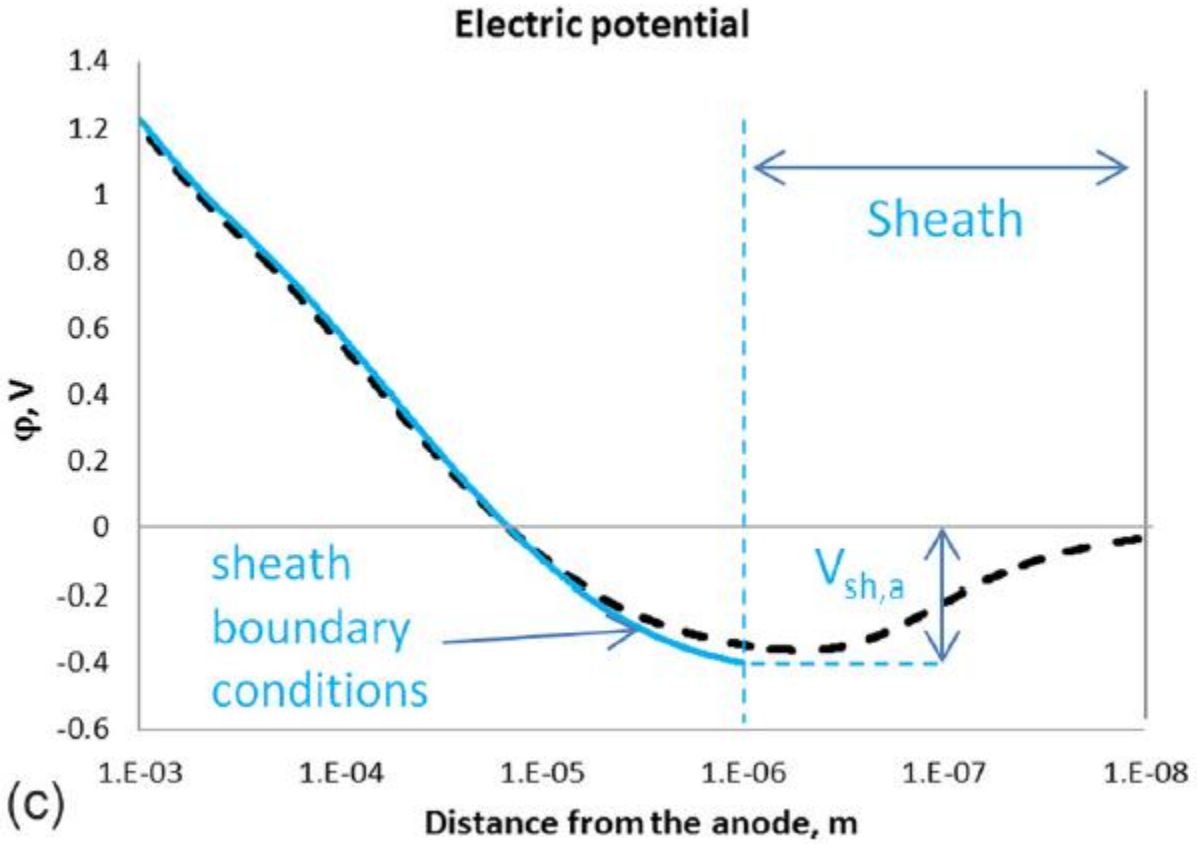
Inverse Sheath in Arc

Potential profile , Arc 1 atmosphere Computational results for the near-anode region. Black dashed/dotted lines show results obtained with sheath resolution approach; blue lines—with the effective sheath boundary conditions.



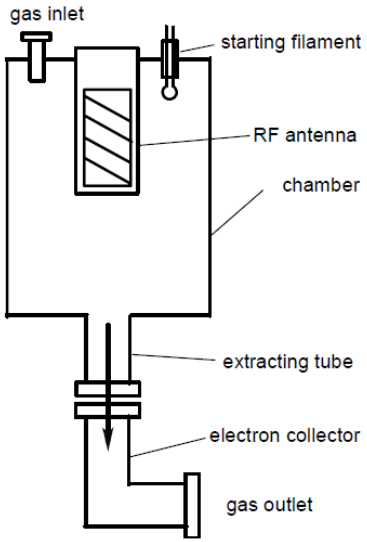
Investigation of the short argon arc with hot anode. I. Numerical simulations of nonequilibrium effects in the near-electrode regions
A. Khrabry, I. D. Kaganovich, V. Nemchinsky, and A. Khodak
Physics of Plasmas **25**, 013521 (2018).
Confirmed by
M. D. Campanell, Alternative model of space-charge-limited thermionic current flow through a plasma
Phys. Rev. E **97**, 043207 (2018)

Comparing emissive and sweeping Langmuir probe measurements in different low temperature plasmas

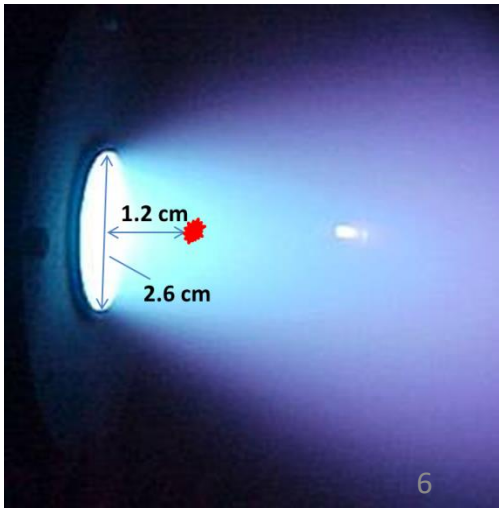
TABLE I. Approximate parameters for each plasma environment considered.

Parameter	Diffuse[22]	RF[26]	With flow[23]
n_e (m^{-3})	3×10^{15}	3×10^{17}	8×10^{16}
T_e^{eff} (eV)	7	4	8
λ_D/r_0	2–3	0.1–0.3	0.6–0.8
$\hat{J}$ (approx.)	200–800	0.04–4	2–20
n_T (m^{-3})	10^{14}	10^{17}	2×10^{15}

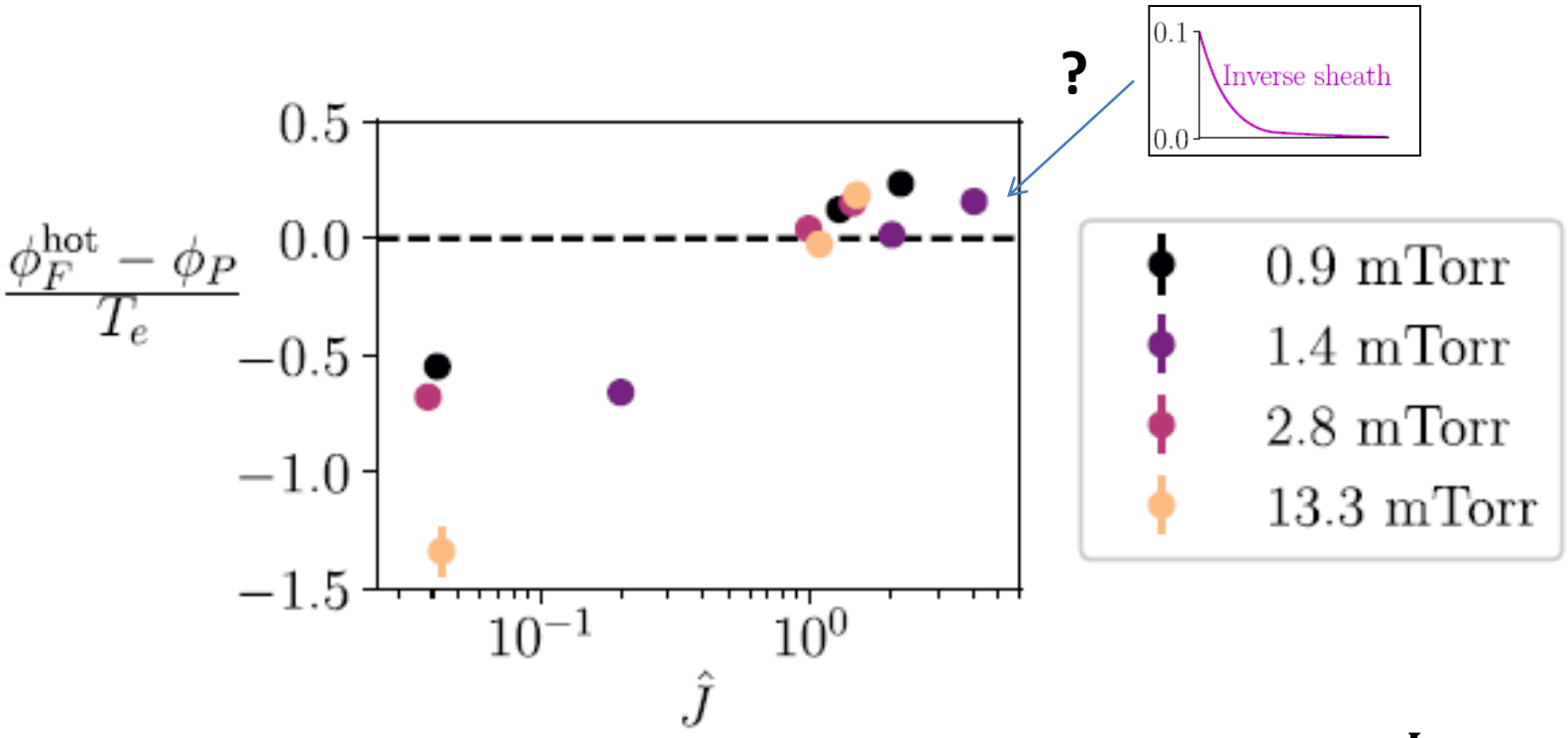
Xe ICP plasma
3 MHz, 100 W



Xe Plume CHT, 200 W with and without magnetic field



ICP plasma: a strongly emitting probe floats above the plasma potential measured with Langmuir probe



- **RF-plasma source at different pressures, $\hat{J} \equiv \frac{J_{ee}}{J_{pe}}$**

Floating emissive probe with very high emission current works not in Hobbs-Wesson space charge limited regime and can measure directly plasma potential $V_{fl} \approx \Phi_{pl}$.

Kraus and Raitses, Phys. Plasmas 25, 030701 (2017)

Unexplained effect of EVDF and flow on floating potential of strongly emitting probe