

HEDLA2012

9th International Conference on High Energy Density Laboratory Astrophysics
Tallahassee, FL April 30-May 4, 2012

Summary of HEDLA-2012

**The 9th International Conference on High Energy Density Laboratory Astrophysics
April 30 – May 4, 2012, Tallahassee, FL**

**Bruce A. Remington
ICF/HED Program
Lawrence Livermore National Laboratory**

Where did we stand after the 1st HEDLA (1996)?

1st HEDLA, Pleasanton, CA, 1996

CONF-960297



Workshop on Laboratory Astrophysics Experiments with Large Lasers
February 26-27, 1996
Lawrence Livermore National Laboratory, Livermore, California



Topics include:

- Hydrodynamic instabilities in supernova evolution
- Impact of SN1987A with its circumstellar ring
- Shock wave — interstellar cloud interactions
- Detailed opacities relevant to stellar interiors
- Radiation and thermal transport
- Dense plasma atomic physics and EOS
- X-ray photoionized plasmas



Summary from HEDLA-1996

Discussion :

All major lasers in world represented here ...

- Better diagnostics ^{Hydro at high compression} (D. Arnett) to observe the details in mix
- Collisionless shocks (E. Waxman)
- Relativistic shocks "
- Relativistic plasmas
- Particle distributions (J. Raymond)
- $T_i > T_e \rightarrow T_i = T_e$ (R. McCray)
- Rad. hydro, MHD, Rad. MHD (J. Stone)
- Open data sets, calculations to community (N. Zubaty)

↳ Code validation group, effort (like the opacity effort)

LANL preprint server

email list of attendees to everyone

electron heat transport

magnetic field (self) generation

strongly coupled plasmas

thermal condensation instability

Burn physics

EOS of H, He, ... ; insul. → metal
Lattice dynamics; 1D → 3D; ν_{triple}
Material properties: T_m
 γ_{eff} , GCP

The conclusion from HEDLA-1996

- The conclusion of the meeting was a consensus that there are areas where careful HED laboratory experiments could serve as an astrophysical testing ground, a setting where emerging theories can have a “dry run”.**
- The challenge is to match the right astrophysics questions with the right HED experiment.**
- We hope that the outcome of this workshop will be the start of a continuing dialog between the astrophysics and HED experimental communities, which will lead to more discriminating astrophysics experiments on HED experimental facilities around the world.**

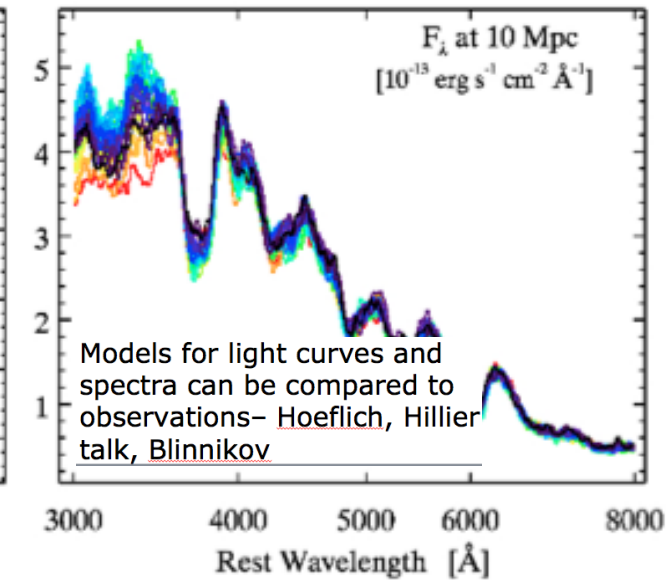
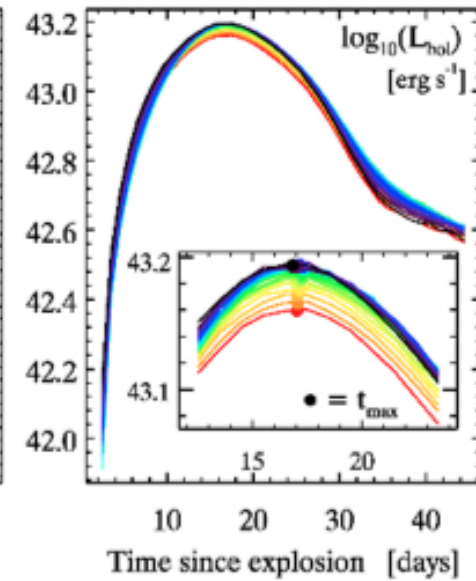
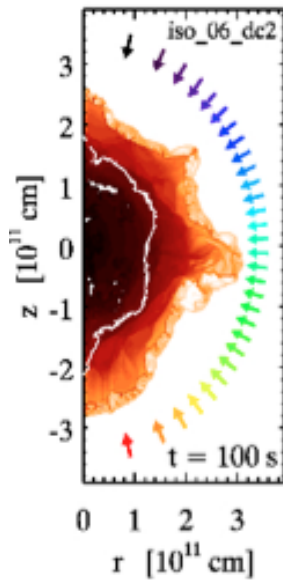
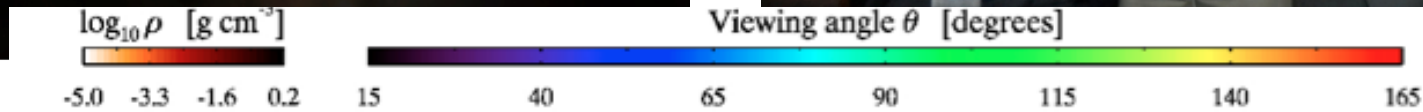
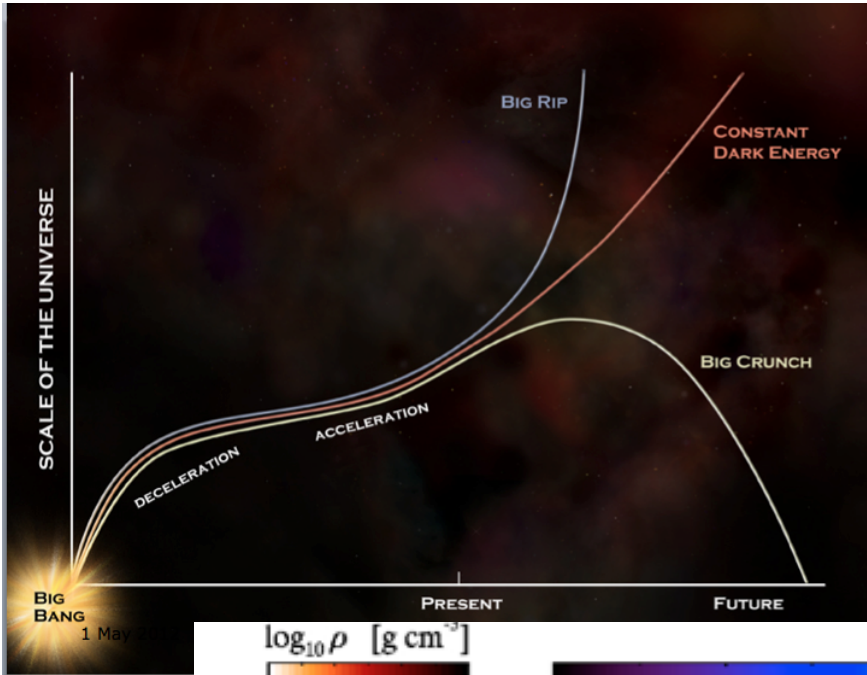
**- Where do we stand
now, 16 yrs later, after
the 9th HEDLA-2012?**

-I'll show just a few highlights

Highlights

Bob Kirshner

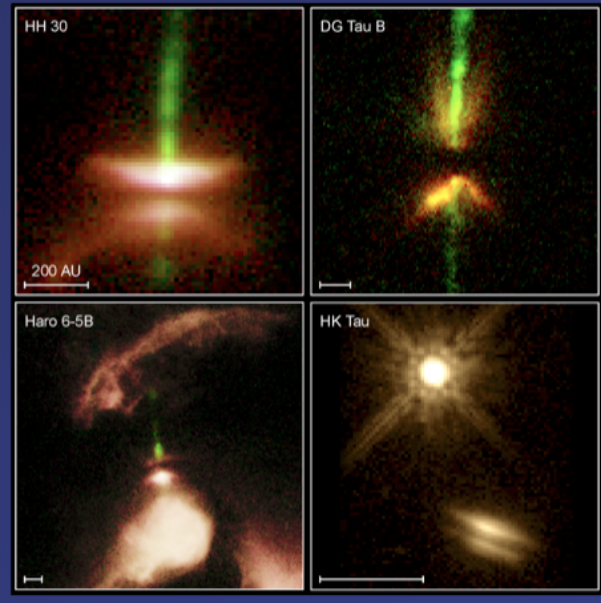
Nobel prize to his former students



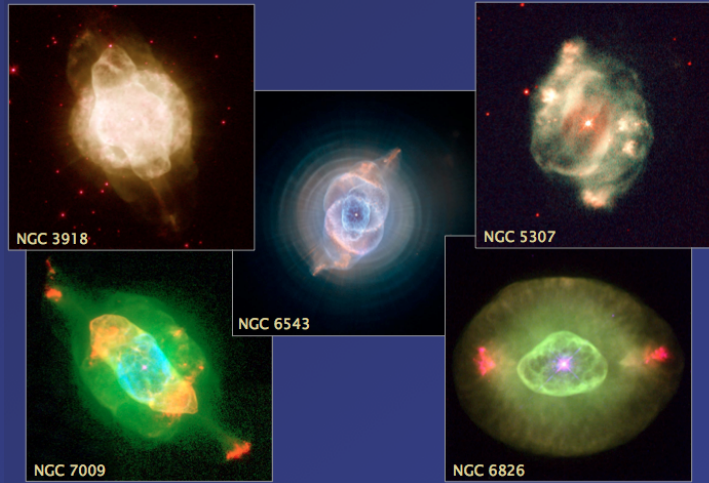
Highlights

Mario Livio, jets to music

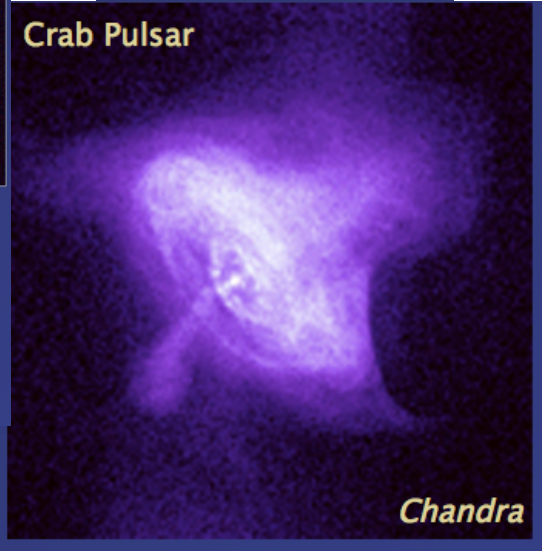
Jets in Young Stellar Objects



Jets in Planetary Nebulae?

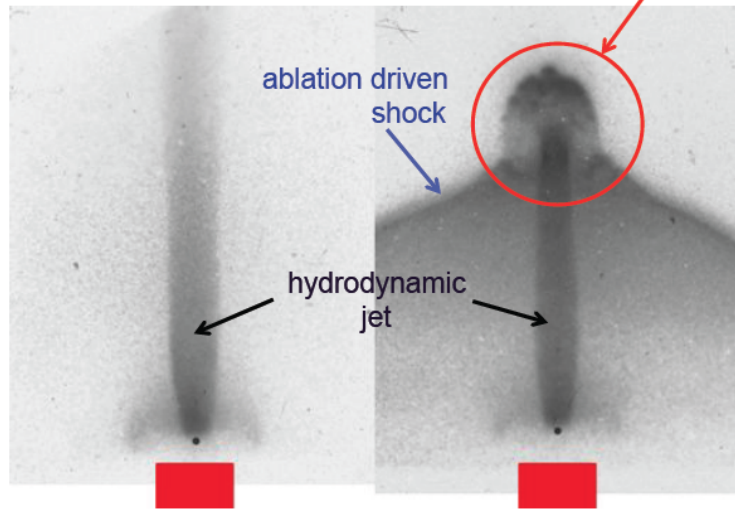


Pulsar Jets (?)



Francisco Suzuki-Vidal, jets

XUV self-emission ($E > 30$ eV)



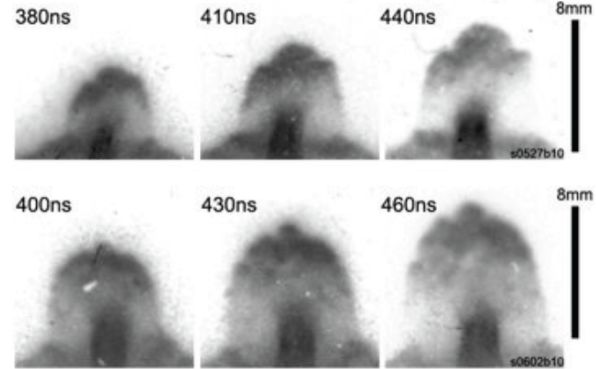
jet in vacuum
437ns

jet in argon
430ns

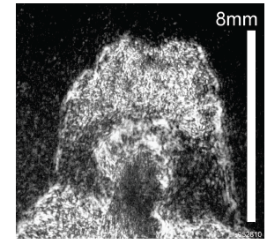
Effect of radiative cooling in the shock

Imperial College London

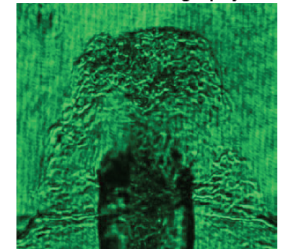
XUV emission in the reference frame of the tip of the ablation shock



Dark-field Schlieren



Laser shadowgraphy



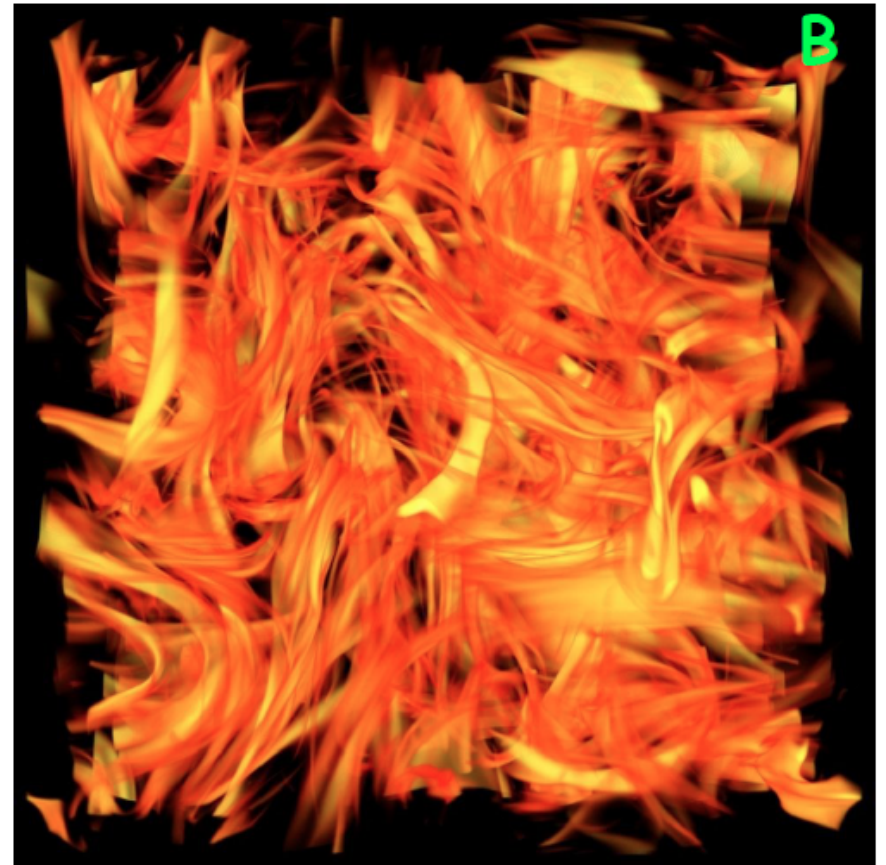
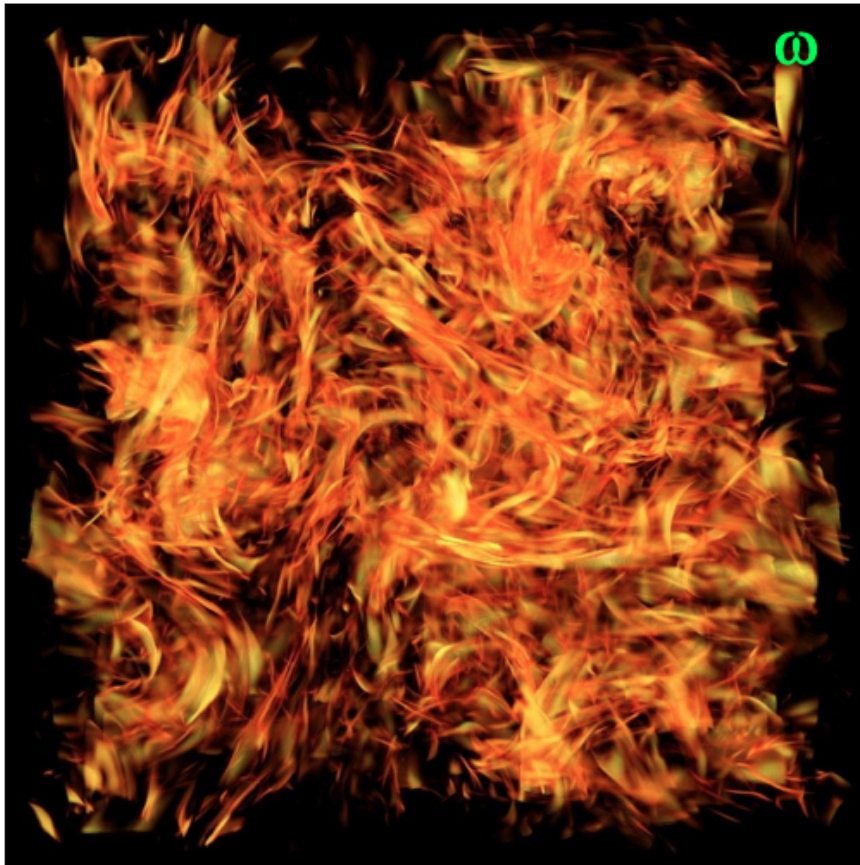
Formation of small scale structures in the bow-shock

$L_{\text{self-emission}} \sim \text{mm}$ $L_{\text{optical probing}} \sim 100\text{-}200 \mu\text{m}$

Highlights

Dongsu Ryu, intracluster (intergalactic) turbulence

A Simulation Study of Intracluster Turbulence



Dongsu Ryu (Chungnam National U, Korea)

Highlights

Jungyeon Cho, (magnetized) turbulence in astrophysical fluids

Example of turbulence: Turbulence created by an alligator



Photo taken during the boat trip



$\nu_{\text{water}} \sim 0.01$
(cgs)

$V = 50 \text{ cm/s}$
& $L = 100 \text{ cm}$
 $\rightarrow \text{Re} \sim 5 \times 10^5!$

Highlights

Michael Wiescher: nucleosynthesis

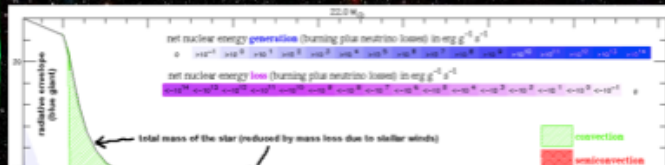
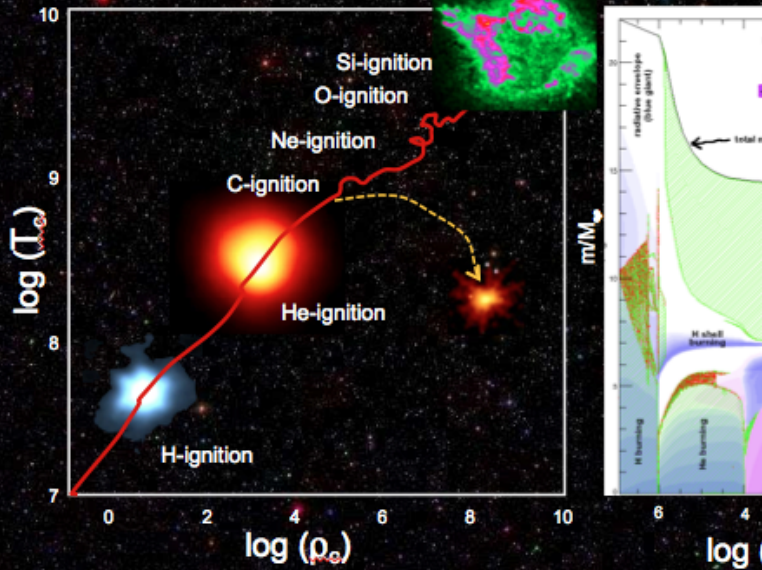
Nucleosynthesis in Stars

Hydrogen Burning: 4He , ^{14}N

Helium Burning: ^{12}C , ^{16}O , ^{22}Ne , n , s -nuclei

Carbon Burning: ^{16}O , ^{20}Ne , ^{24}Mg ... s -nuclei

Ne-, O-, Si-Burning: ^{56}Fe but shell distributions

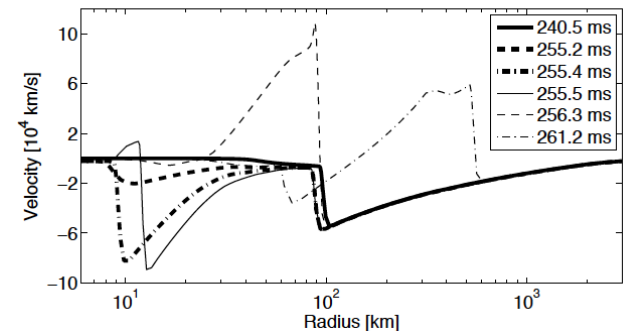
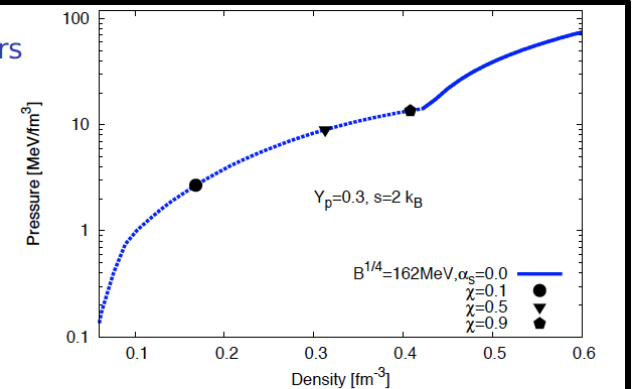


Light and intermediate progenitors

- Mixed phase at core bounce in the center of the proto neutron star
- Softening of the mixed phase EoS for growing χ
- Collapse of proto neutron star
- Stiffening of quark EoS halts collapse
- Formation of second shock wave

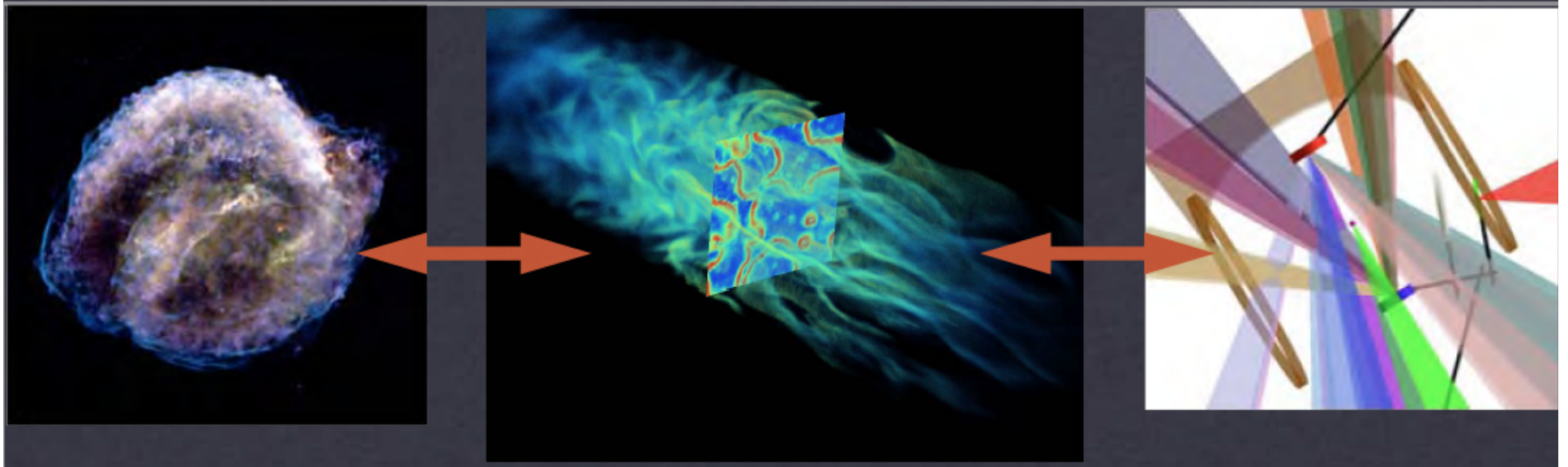
I. S., T. Fischer, M. Hempel, G. Pagliara, J. Schaffner-Bielich, A. Mezzacappa, F.-K. Thielemann, M. Liebendoerfer, PRL 102, 081101 (2009); Fischer et al., ApJS 194, 39 (2011)

Irina Sagert: hadron-quark phase transition, nuclear EOS



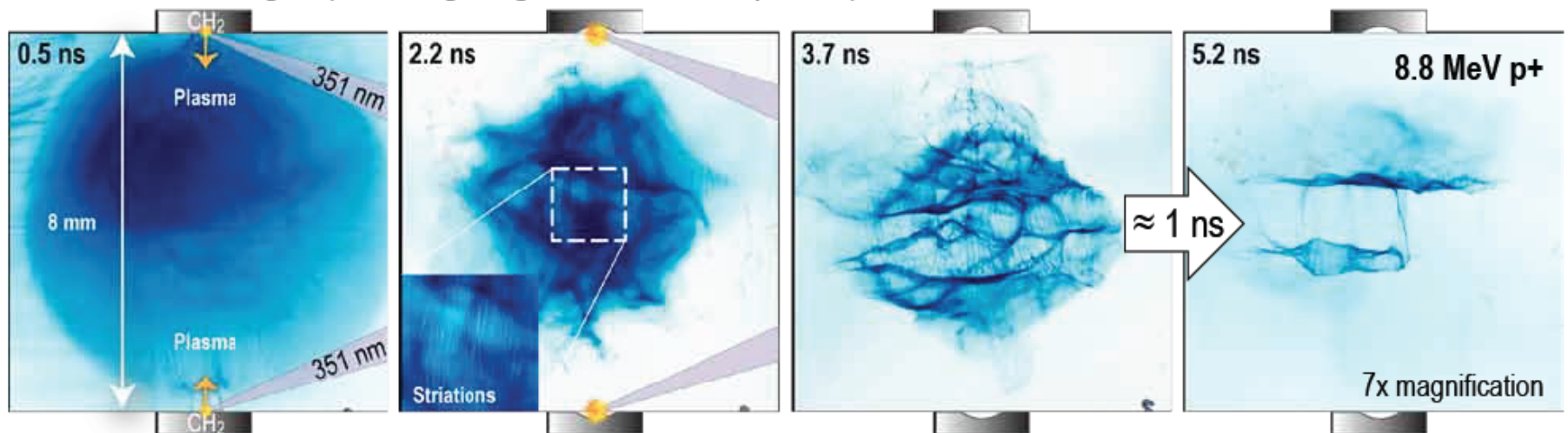
Highlights

Anatoly Spitkovsky, and the ACSEL collaboration



OMEGA EP laser ablation: 2.2 kJ in 3 ns
Proton images (0.2 ns "gating", multi-shot sequence)

Nathan Kugland, Hye-Sook Park,
and the ACSEL collaboration



Highlights

Jim Bailey, opacities

Sandia National Laboratories

ZAPP: THE Z ASTROPHYSICAL PLASMA PROPERTIES COLLABORATION

Jim Bailey
HEDLA
 Tallahassee, Florida
 May 1, 2012

Preliminary measurements at solar conditions indicate the next year should be exciting for stellar opacity research

transmission

← Z data
150 eV, 8e21 e/cc

→ calculation (OPAS)

transmission

← Z data
190 eV, 7e22 e/cc

→ calculation (PrismSPECT)

1000 1100 1200 1300
hν (eV)

OP model used in stellar research disagrees with data for all Z experiments

Best effort models agree at lower n_e/T_e , but disagree significantly at stellar interior conditions

More experiments needed to confirm this result

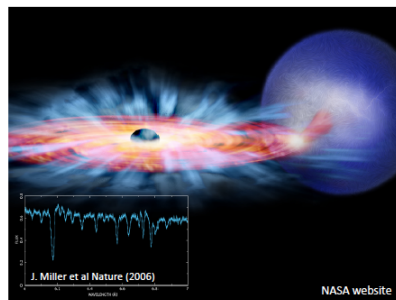
Bailey et al., POP (2009)

Roberto Mancini, photoionized plasmas

- Widespread in space – active galactic nuclei, accretion discs around black holes
- Plasma is driven by an intense source of X-rays
- Unlike collisional plasmas, photo-ionisation and photo-excitation dominate atomic kinetics
- The complexity of the astrophysical environment makes the spectral analysis challenging → laboratory experiments are important¹

Relevance to astrophysics

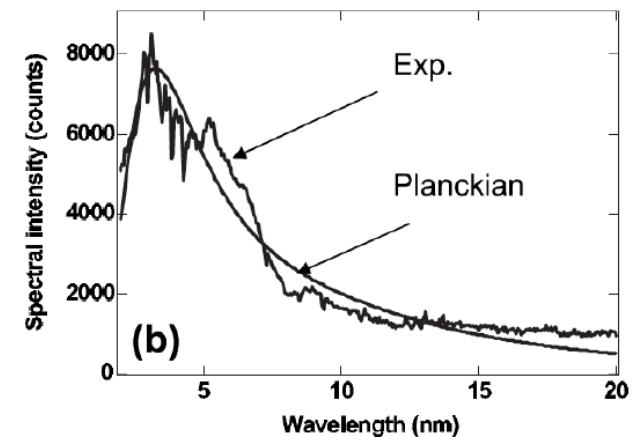
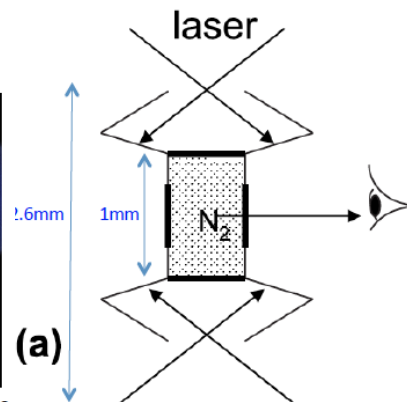
- Perform well-characterized laboratory photoionized plasma experiments to benchmark modeling codes developed only from theory
- Address specific problems: e.g. effect of resonant Auger destruction on radiative properties of accreting disks



Artists impression of binary system GRO J1655-40, 11,000 lights years away in scorpion constellation

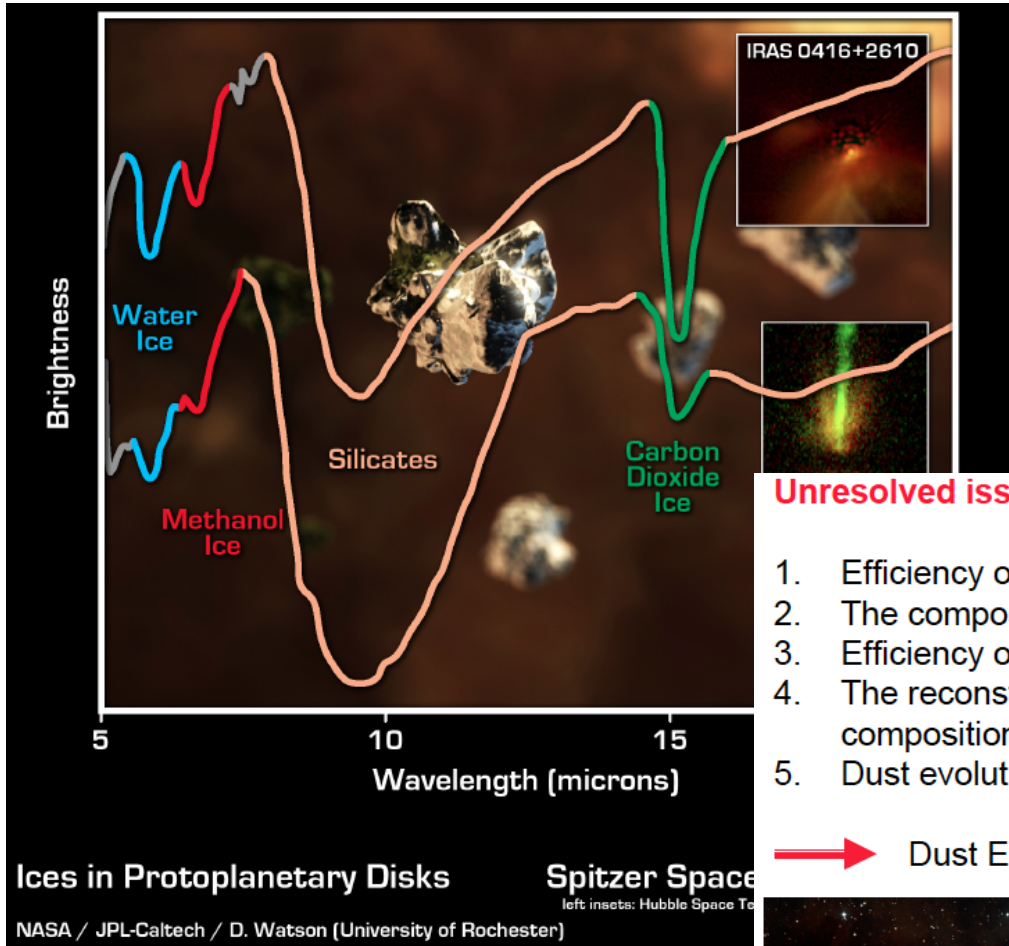
¹ R. C. Mancini et al, Phys. Plasmas **16**, 041001 (2009)

Fei-lu Wang et al, PoP **15**, 073108 (2008): experiment concept
 “Dog-bone” hohlraum cavity $T_e = 80\text{eV}$



Highlights

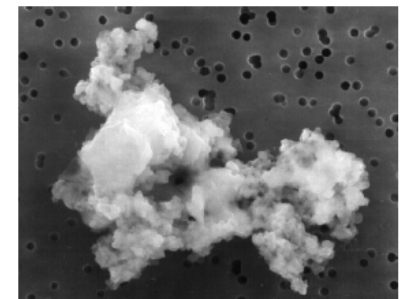
Farid Salama, dust



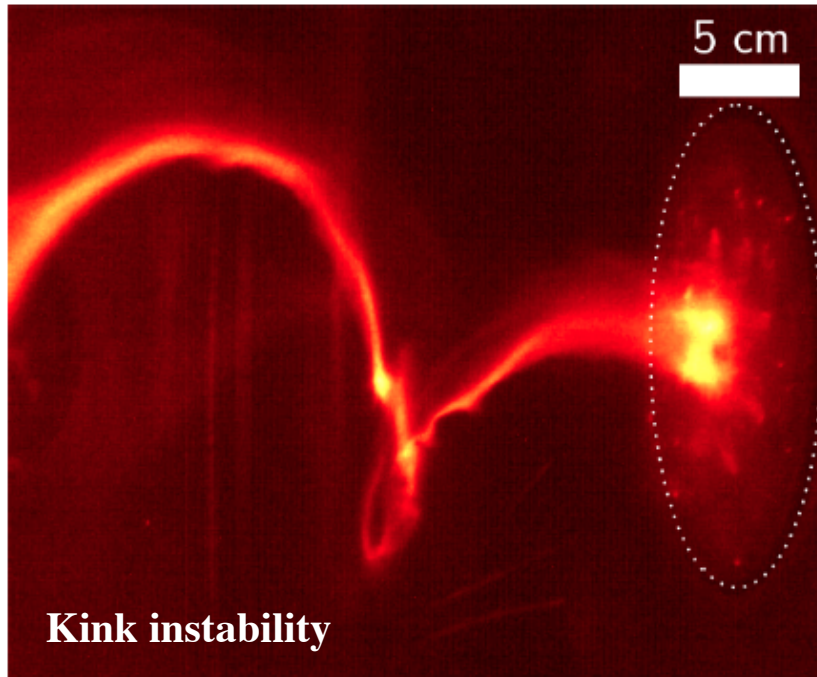
Unresolved issues:

1. Efficiency of dust formation in various sources, especially in supernovae
2. The composition and survival of the newly formed dust
3. Efficiency of dust destruction
4. The reconstitution of dust particles by accretion and the resulting dust composition.
5. Dust evolution .

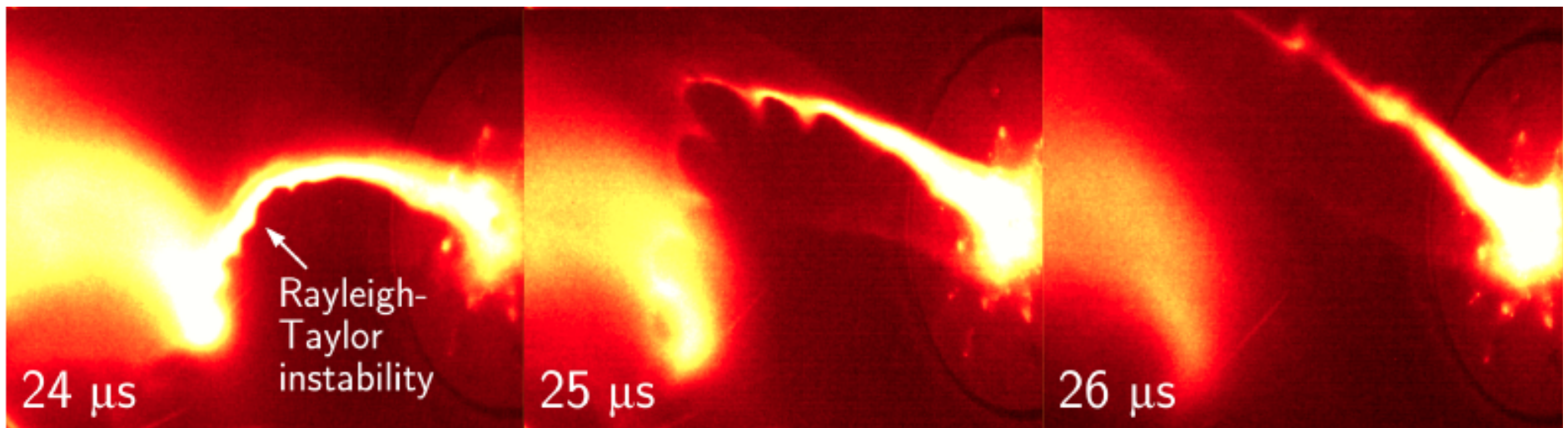
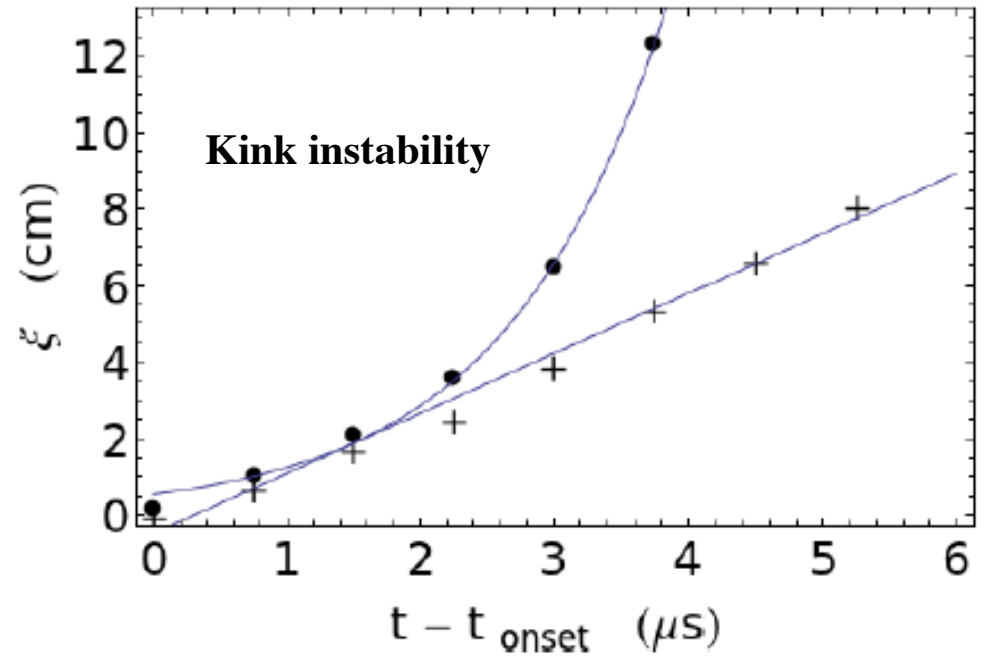
→ Dust Evolution: Formation, Processing, Destruction?



Highlights

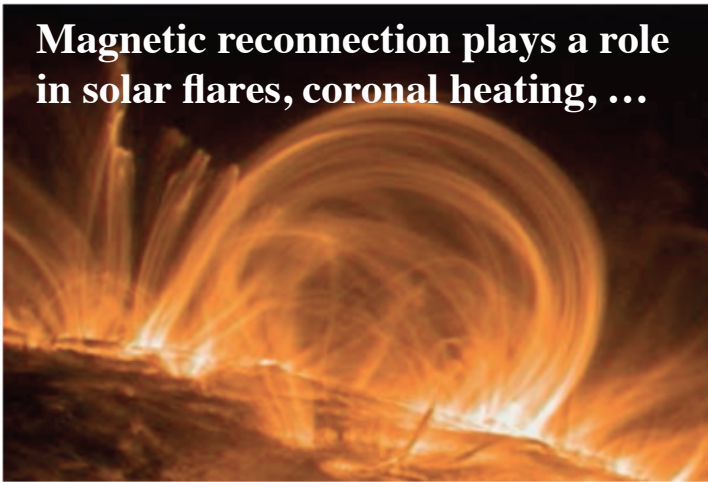


Auna Moser:
kink instability + Rayleigh-Taylor instability,
magnetic reconnection?

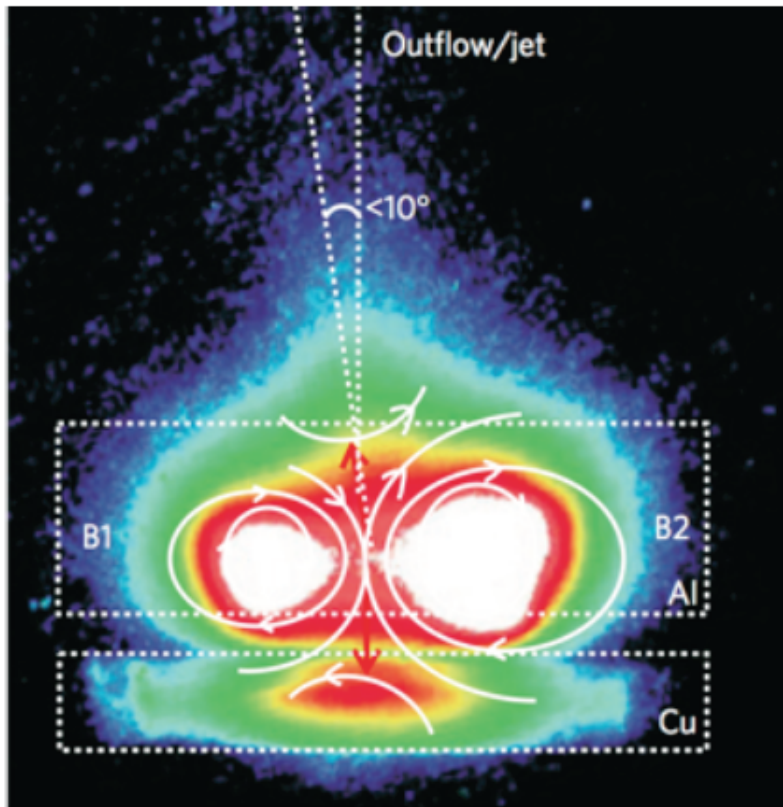


Highlights

Magnetic reconnection plays a role in solar flares, coronal heating, ...

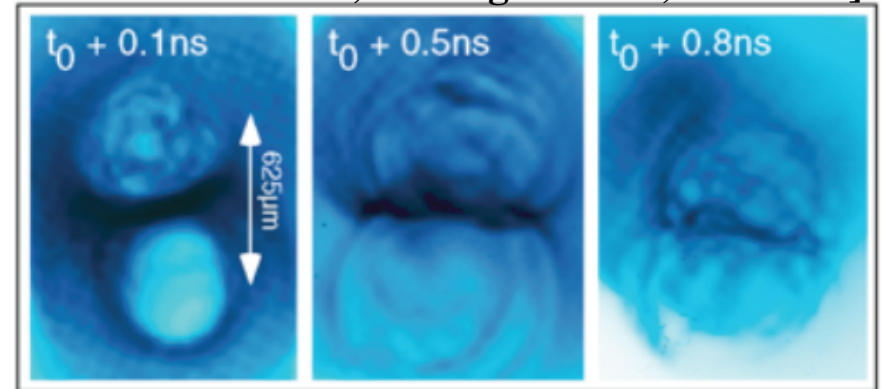


Shenguang [Zhong et al., Nature Phys. 2010]

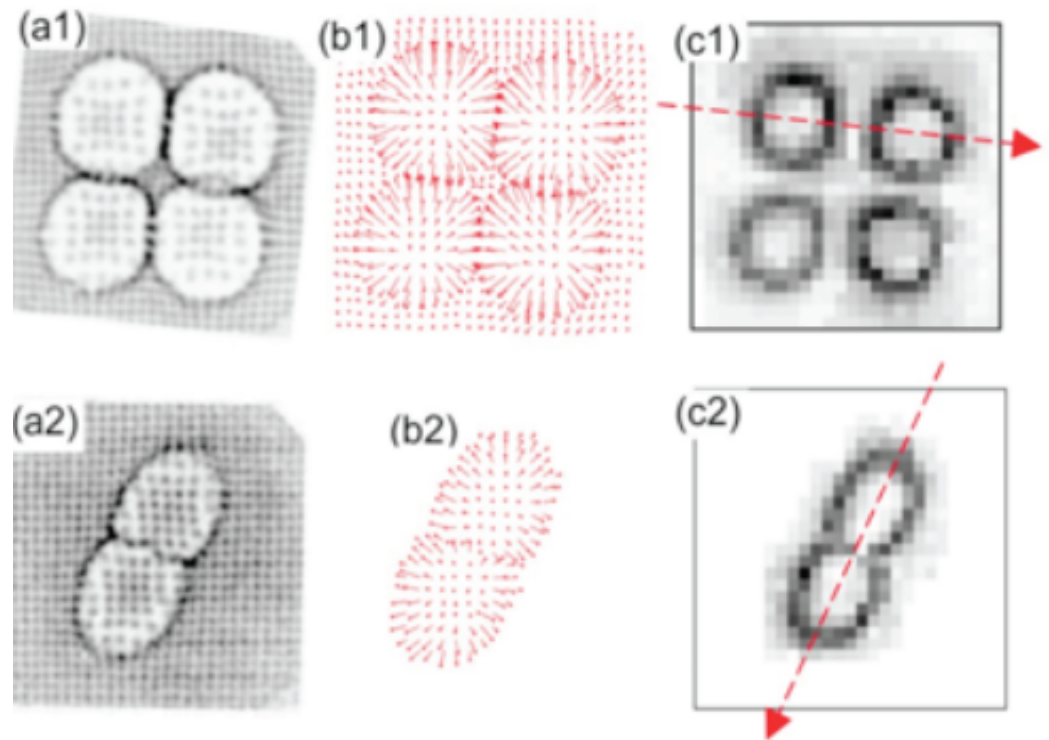


Wil Fox, fast magnetic reconnection in HED laser produced plasmas

Rutherford [Nilson et al., PRL 2006, PoP 2008; Willingale et al., PoP 2010]



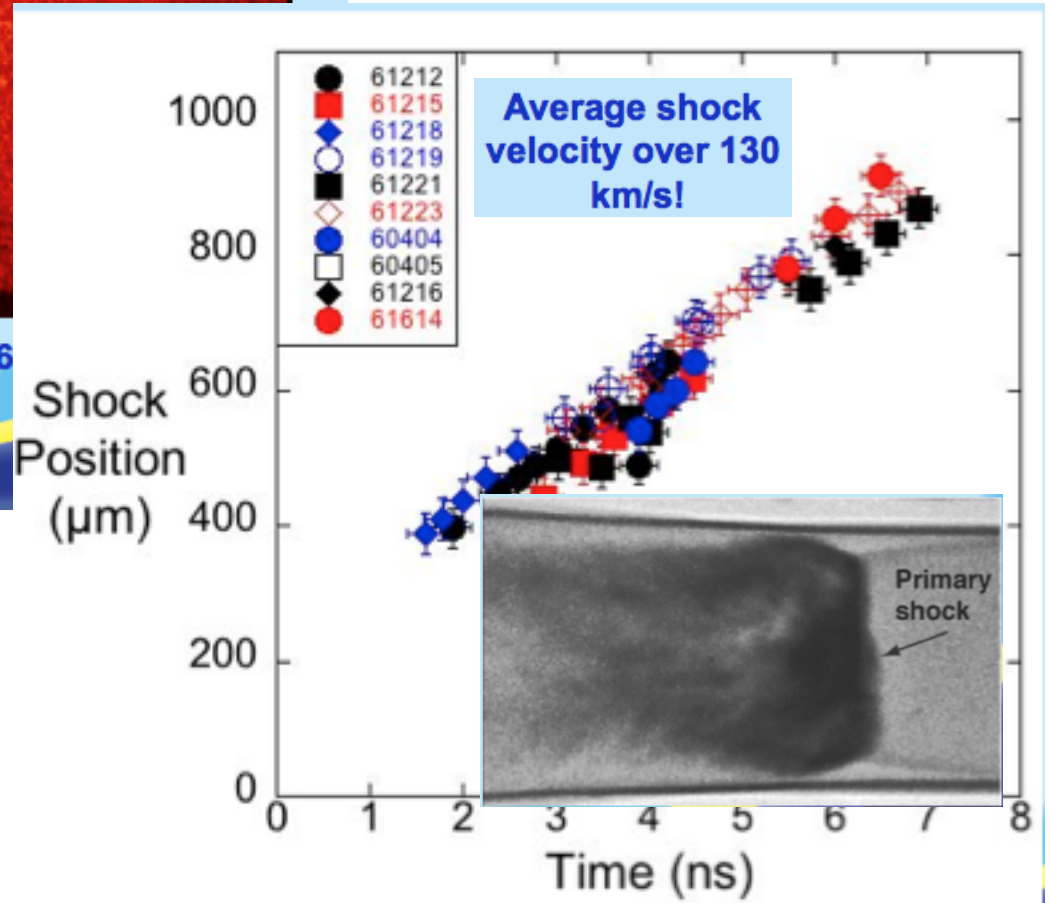
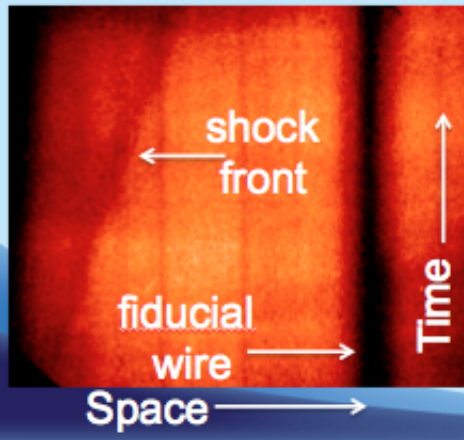
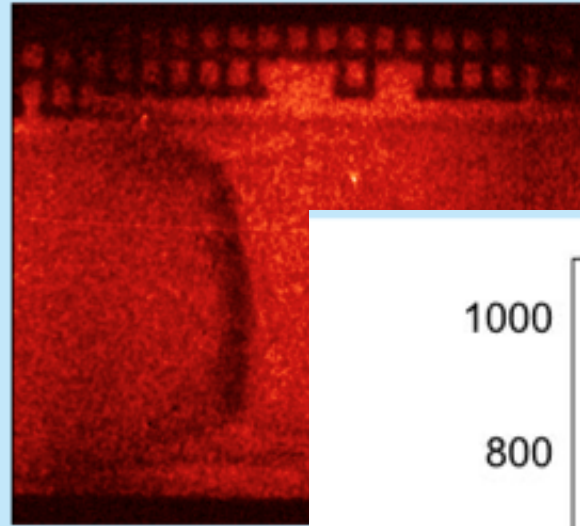
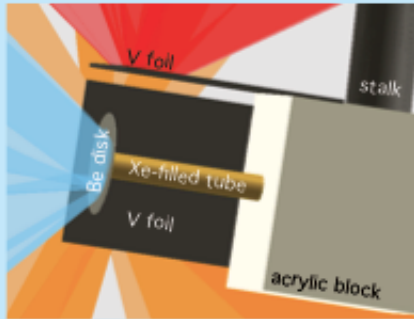
Omega [C.K. Li et al., PRL 2007]



Highlights

Carolyn Kuranz, radiative shocks

We observe these shocks with x-ray radiography from 2 views

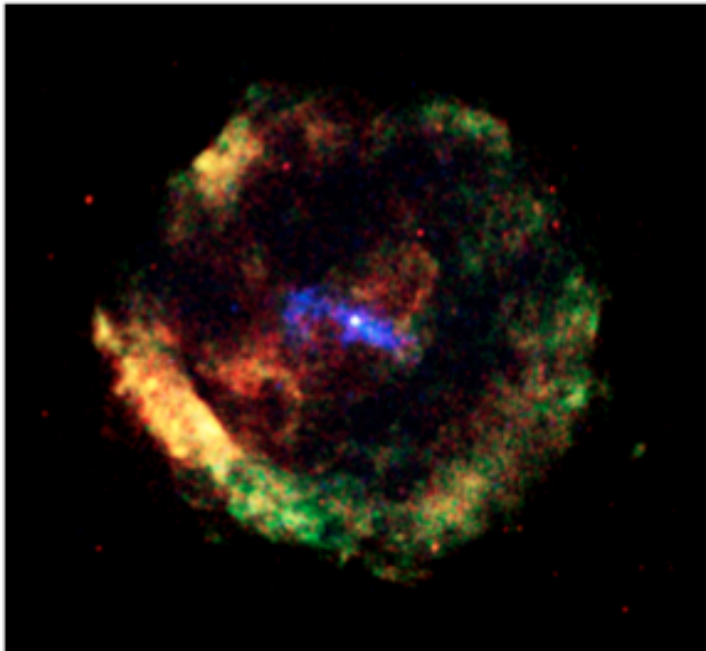
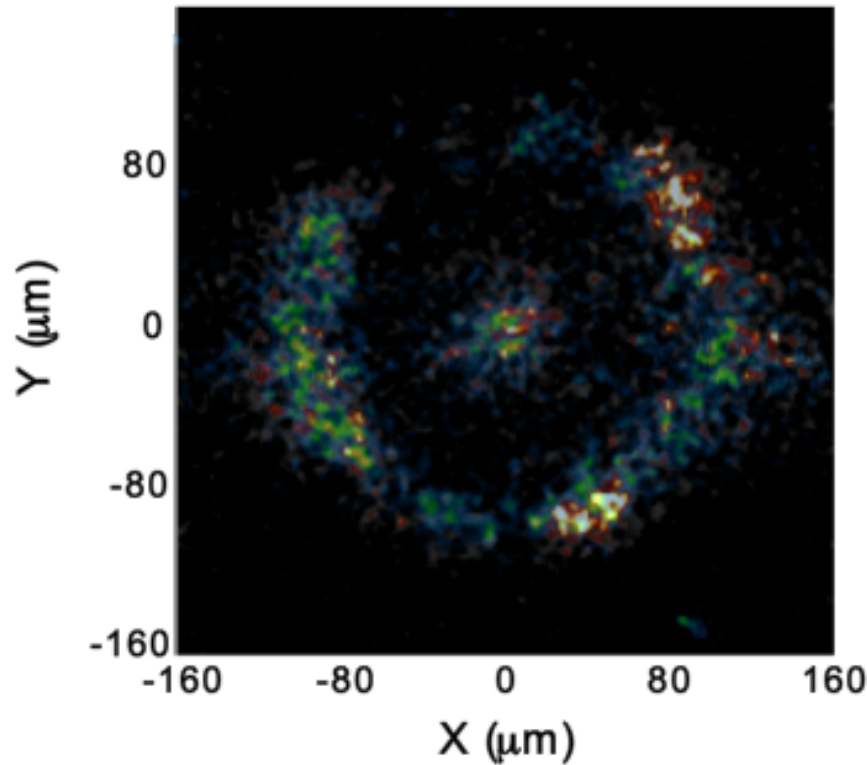


At late time, we observe a radiative shock wave with supernova-like features

X-ray emission at $t = 400$ ps after peak compression

Super nova remnant G11.2-0.3

Siegfried Glenzer, radiative shocks in NIF implosions



At high pressures of > 20 Gbar, NIF implosions show strongly emitting shock wave [>6 keV filtering]

In Chandra's X-ray image. A shell of heated gas from the outer layers of the exploded star surrounds the pulsar and emits lower-energy X-rays

The goal of HEDLA is to bring two communities together:

- laboratory experiments and simulations of reality**
- astrophysics and astronomy,**

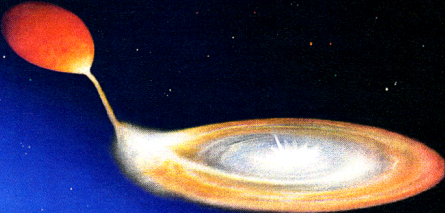
to learn from each other, and improve our collective science

1st HEDLA in Pleasanton, CA in 1996

CONF-960297



Workshop on Laboratory Astrophysics Experiments with Large Lasers
February 26–27, 1996
Lawrence Livermore National Laboratory, Livermore, California

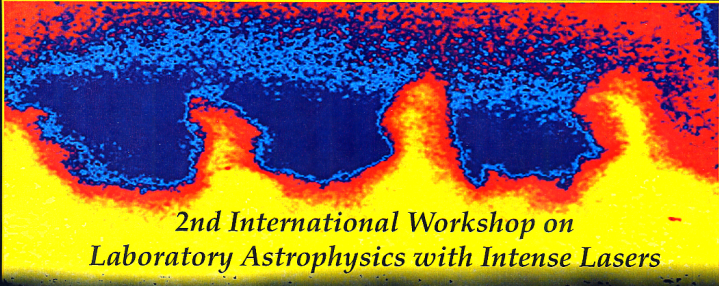


Topics include:


- Hydrodynamic instabilities in supernova evolution
- Impact of SN1987A with its circumstellar ring
- Shock wave — interstellar cloud interactions
- Detailed opacities relevant to stellar interiors
- Radiation and thermal transport
- Dense plasma atomic physics and EOS
- X-ray photoionized plasmas



2nd HEDLA in Tucson in 1998



2nd International Workshop on Laboratory Astrophysics with Intense Lasers


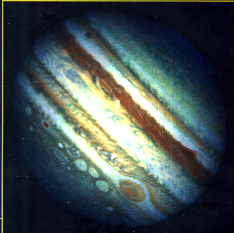
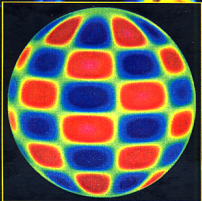


Topics Include:

- Hydrodynamic instabilities in astrophysics
- Supernovae and supernova remnant evolution
- Astrophysical shocks, blast waves, and jets
- Stellar opacities
- Radiation and thermal transport
- Dense plasma atomic physics and EOS
- X-ray photoionized plasmas

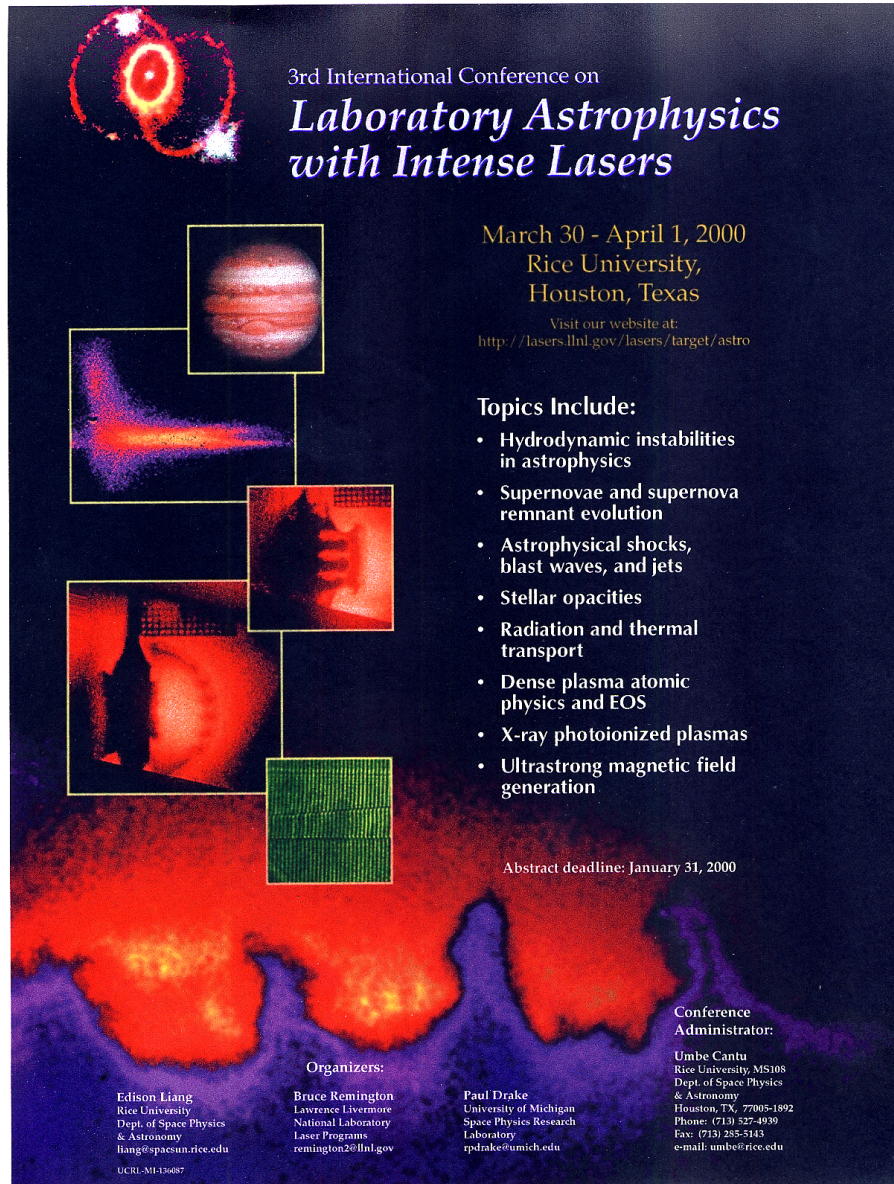
March 19–21, 1998
University of Arizona
Tucson, Arizona

Visit our website at:
<http://lasers.llnl.gov/lasers/target/astro>



- Proceedings in *Ap. J. Suppl.* 127, No. 2 (April, 2000)

3rd HEDLA in Houston, TX in 2000



3rd International Conference on
**Laboratory Astrophysics
with Intense Lasers**

March 30 - April 1, 2000
Rice University,
Houston, Texas

Visit our website at:
<http://lasers.llnl.gov/lasers/target/astro>

Topics Include:

- Hydrodynamic instabilities in astrophysics
- Supernovae and supernova remnant evolution
- Astrophysical shocks, blast waves, and jets
- Stellar opacities
- Radiation and thermal transport
- Dense plasma atomic physics and EOS
- X-ray photoionized plasmas
- Ultrastrong magnetic field generation

Abstract deadline: January 31, 2000

Organizers:

Edison Liang
Rice University
Dept. of Space Physics
& Astronomy
liang@spacsun.rice.edu

Bruce Remington
Lawrence Livermore
National Laboratory
Laser Programs
remington2@llnl.gov

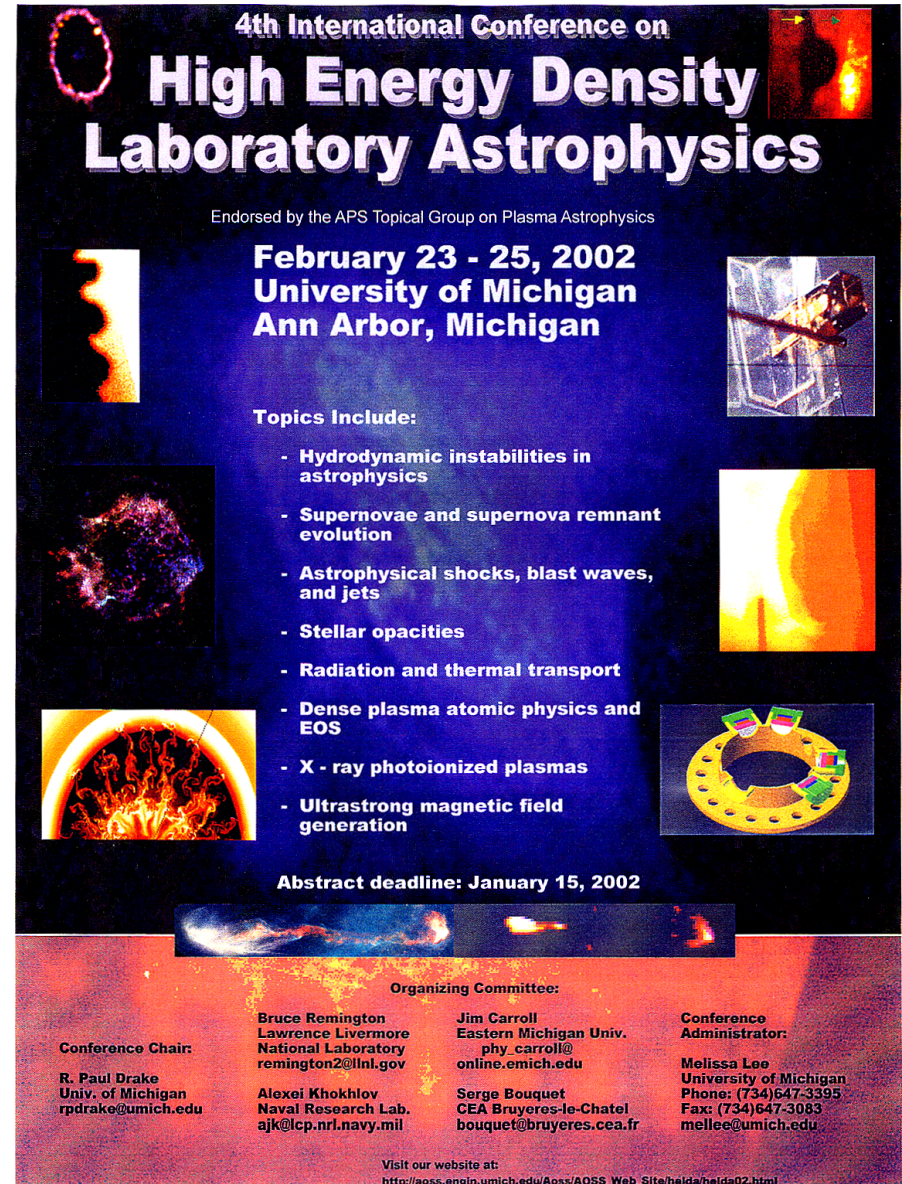
Paul Drake
University of Michigan
Space Physics Research
Laboratory
pdrake@umich.edu

Conference Administrator:

Umbe Cantu
Rice University, MS108
Dept. of Space Physics
& Astronomy
Houston, TX, 77005-1892
Phone: (713) 527-4939
Fax: (713) 285-5143
e-mail: umbe@rice.edu

UCRL-MI-13687

4th HEDLA in Ann Arbor, MI in 2002



4th International Conference on
**High Energy Density
Laboratory Astrophysics**

Endorsed by the APS Topical Group on Plasma Astrophysics

February 23 - 25, 2002
University of Michigan
Ann Arbor, Michigan

Topics Include:

- Hydrodynamic instabilities in astrophysics
- Supernovae and supernova remnant evolution
- Astrophysical shocks, blast waves, and jets
- Stellar opacities
- Radiation and thermal transport
- Dense plasma atomic physics and EOS
- X - ray photoionized plasmas
- Ultrastrong magnetic field generation

Abstract deadline: January 15, 2002

Organizing Committee:

Conference Chair:
R. Paul Drake
Univ. of Michigan
rpdrake@umich.edu

Bruce Remington
Lawrence Livermore
National Laboratory
remington2@llnl.gov

Alexei Khokhlov
Naval Research Lab.
ajk@cp.nrl.navy.mil

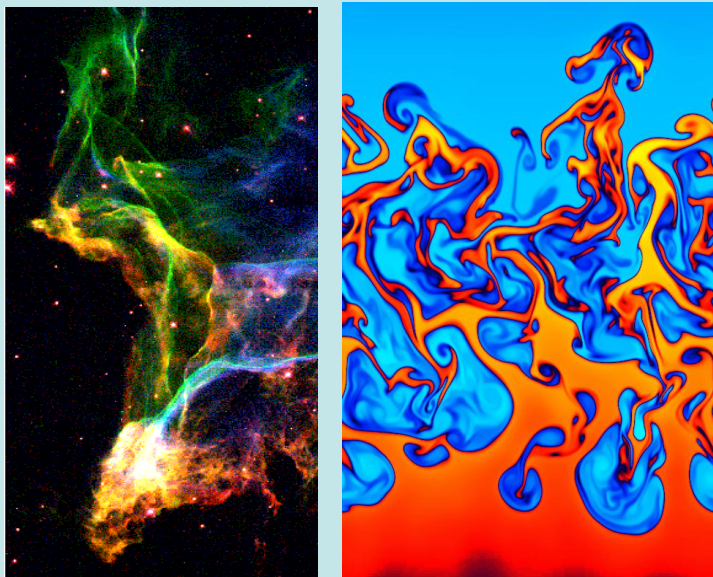
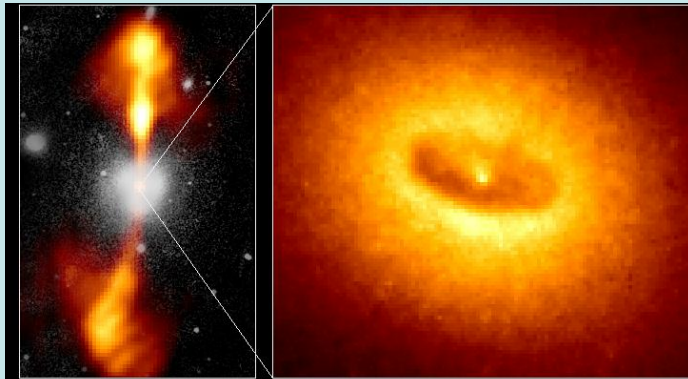
Jim Carroll
Eastern Michigan Univ.
phy_carroll@
online.emich.edu

Serge Bouquet
CEA Bruyeres-le-Chatel
bouquet@bruyeres.cea.fr

Conference Administrator:
Melissa Leo
University of Michigan
Phone: (734)647-3395
Fax: (734)647-3083
mellee@umich.edu

Visit our website at:
http://aoss.engin.umich.edu/Aoss/AOSS_Web_Site/aida/aida02.html

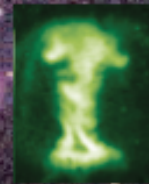
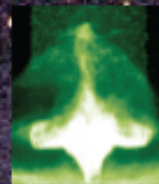
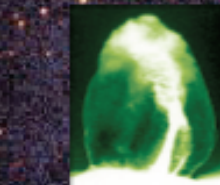
**5th International Conference
on High Energy Density
Laboratory Astrophysics
Tucson, Arizona
March 10-13, 2004,**



**6th International Conference on
High Energy Density Laboratory Astrophysics**



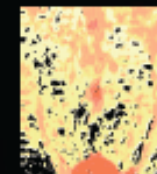
**March 11-14, 2006
Rice University, Houston, Texas**



Topics include:

- Stellar evolution, stellar envelopes, opacities, radiation transport
- Planetary interiors, high-pressure EOS, dense plasma atomic physics
- Supernovae, gamma-ray bursts, exploding systems, strong shocks, turbulent mixing
- Supernova remnants, shock processing, radiative shocks
- Astrophysical jets, high-Mach-# flows, magnetized radiative jets, magnetic reconnection
- Compact object accretion disks, x-ray photoionized plasmas
- Ultrastrong fields, particle acceleration, collisionless shocks

Abstract deadline:
January 13, 2006
www.hedla.org



Conference Administrator:

Umberto Camu
Rice University
umbe@rice.edu
713/348-4838 (tel.)
713/348-5143 (fax)

Edison Liang
Local Committee Chair
Rice University
liang@space.rice.edu

George Kyrala
Program Chair
LANL
kyrala@lanl.gov

Organizing Committee:

Paul Drake
University of Michigan
pdrake@umich.edu

Bruce Remington
LLNL
remington@llnl.gov

Sergey Lebedev
Imperial College
s.lebedev@imperial.ac.uk

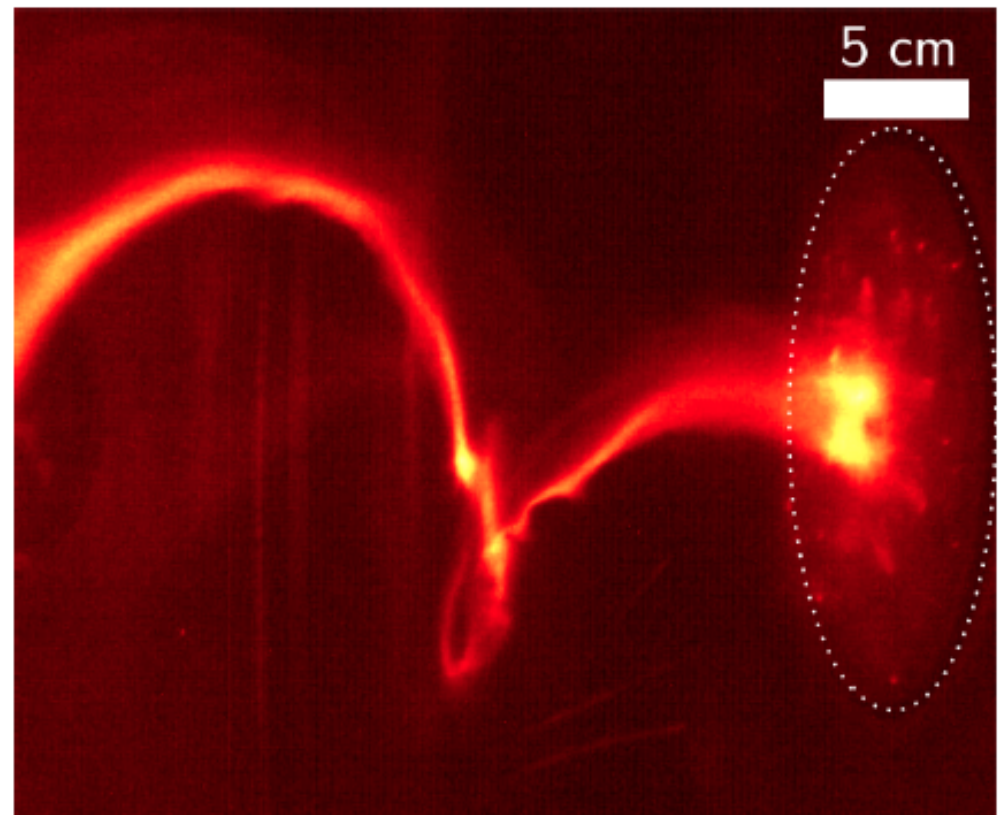
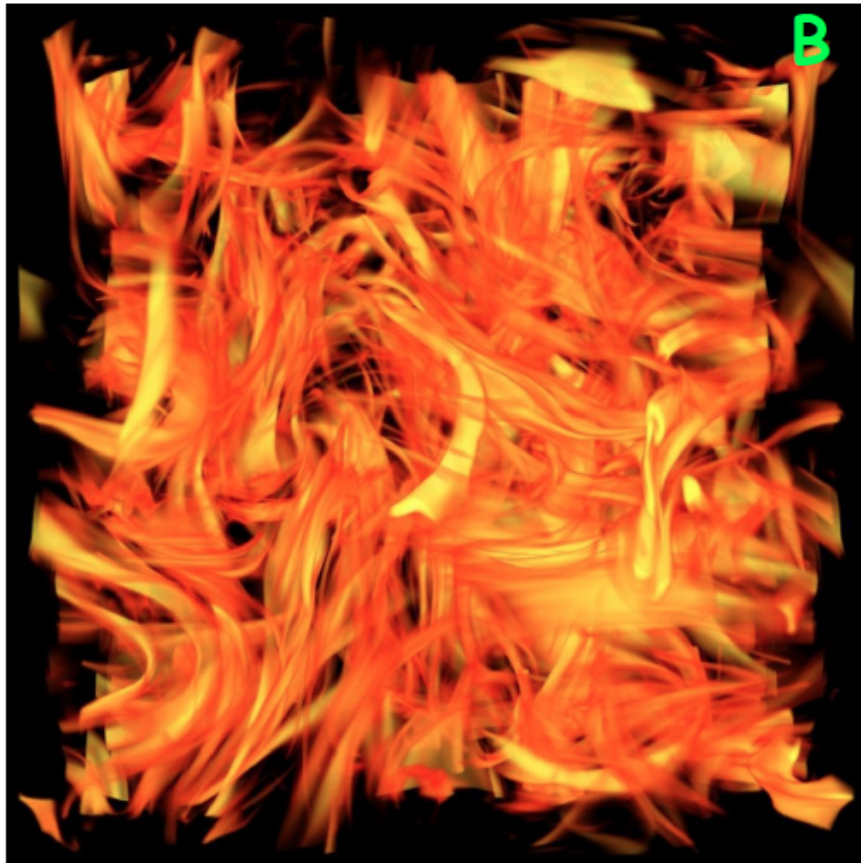
Hideaki Takabe
Osaka University
takabe@le.osaka-u.ac.jp

Scientific Advisory Committee:

Paul Bellan, California Inst. of Technology
Serge Bouquet, Commissariat Energie Atomique
Adam Frank, University of Rochester
Patrick Hardgan, Rice University
Masahiro Hoshino, University of Tokyo
Michel Koenig, Ecole Polytechnique
Hui Li, LANL
Shinji Mitsuoka, Kyoto University
Tom Ray, Dublin Inst. for Advanced Studies
Wim van Breugel, LLNL

HEDLA2012

9th International Conference on High Energy Density
Tallahassee, FL April 30-May 4, 2012



HEDLA2012

9th International Conference on High Energy Density Laboratory Astrophysics
Tallahassee, FL April 30-May 4, 2012

- Thank you for coming

HEDLA2012

9th International Conference on High Energy Density Laboratory Astrophysics
Tallahassee, FL April 30-May 4, 2012

- Thank you for coming

- Thank you Tomek



HEDLA2012

9th International Conference on High Energy Density Laboratory Astrophysics
Tallahassee, FL April 30-May 4, 2012

- **Thank you for coming**

- **Thank you Tomek**

- **Thank you Marc**

- **Thank you Pat**

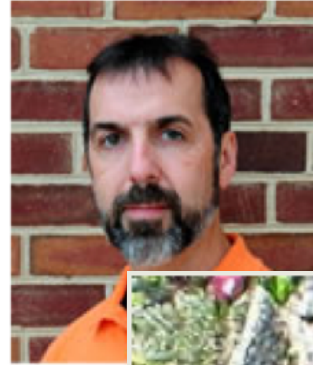
- **See you in 2014 in Bordeaux**



HEDLA2012

9th International Conference on High Energy Density Laboratory Astrophysics
Tallahassee, FL April 30-May 4, 2012

- **Thank you for coming**

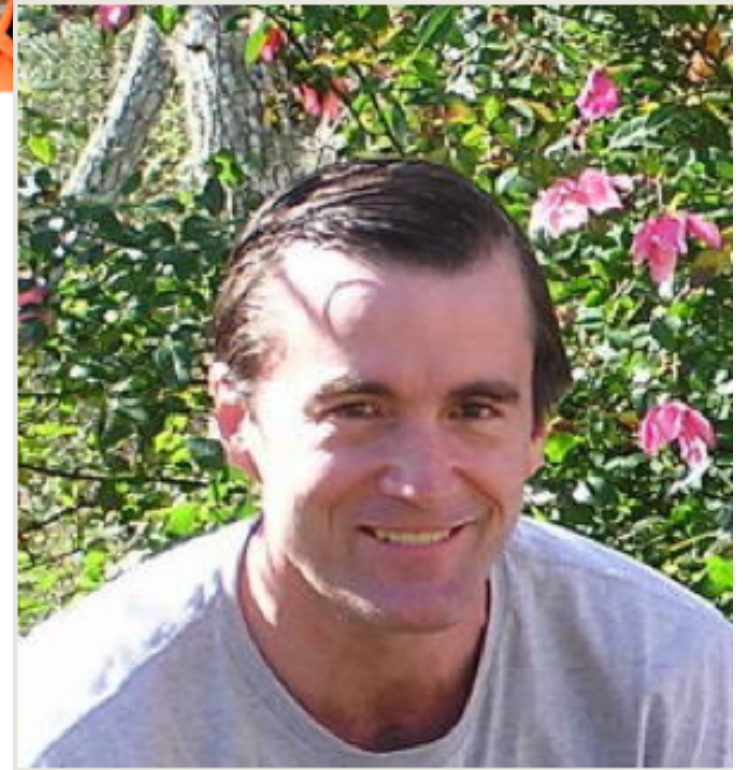


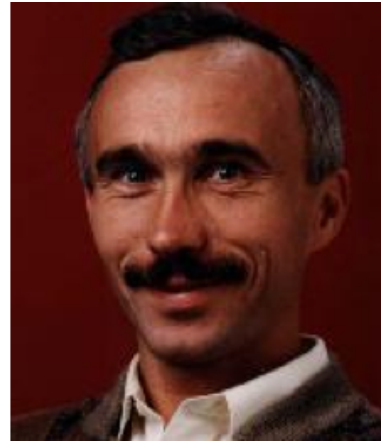
- **Thank you Tomek**

- **Thank you Marc**

- **Thank you Pat**

- **See you in 2014 in Bordeaux**





- Thank you for coming

- Thank you Tomek

- Thank you Marc

- Thank you Pat

- See you in 2014 in Bordeaux

