Where do we go from here?

Luke Drury

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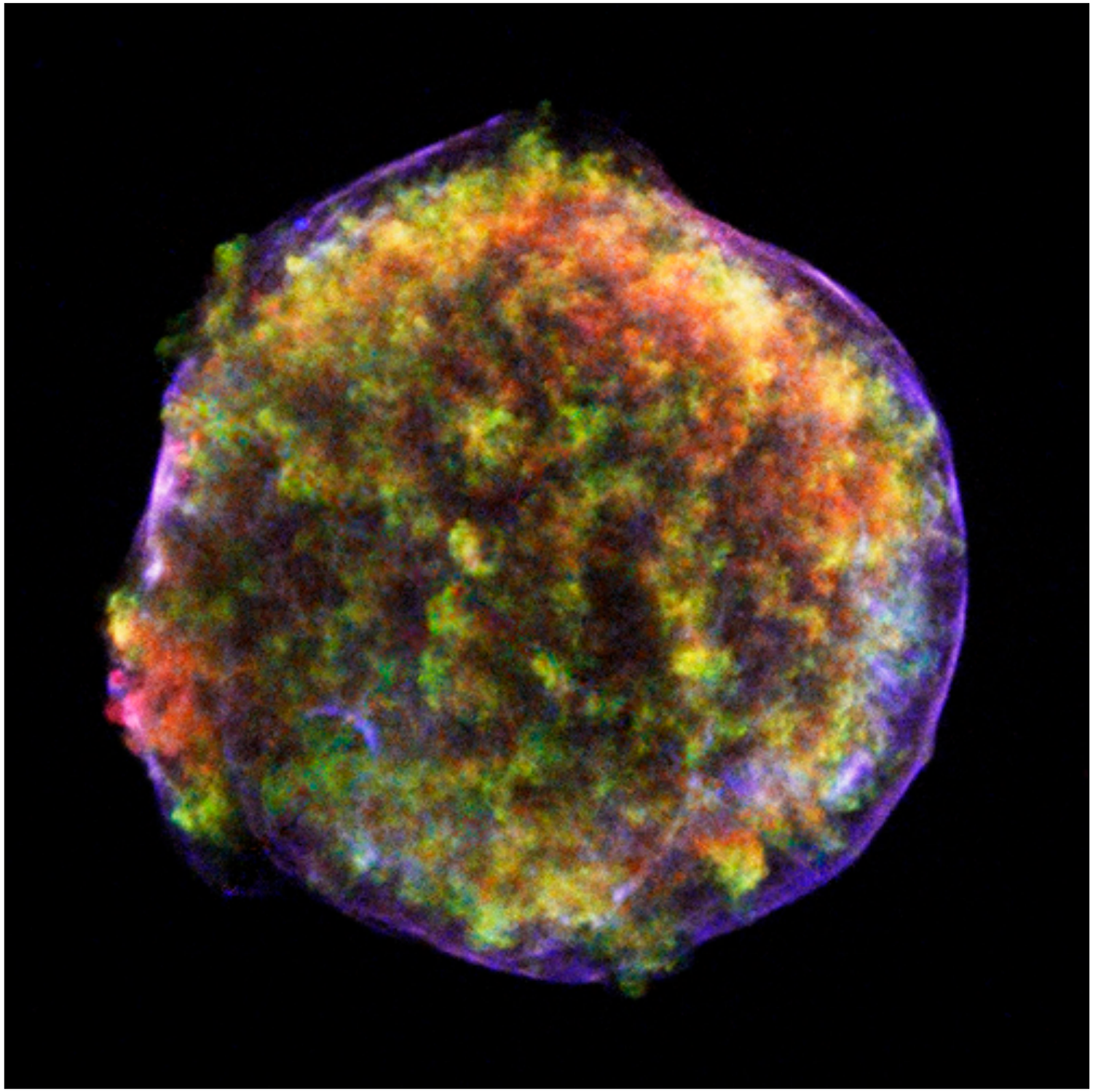
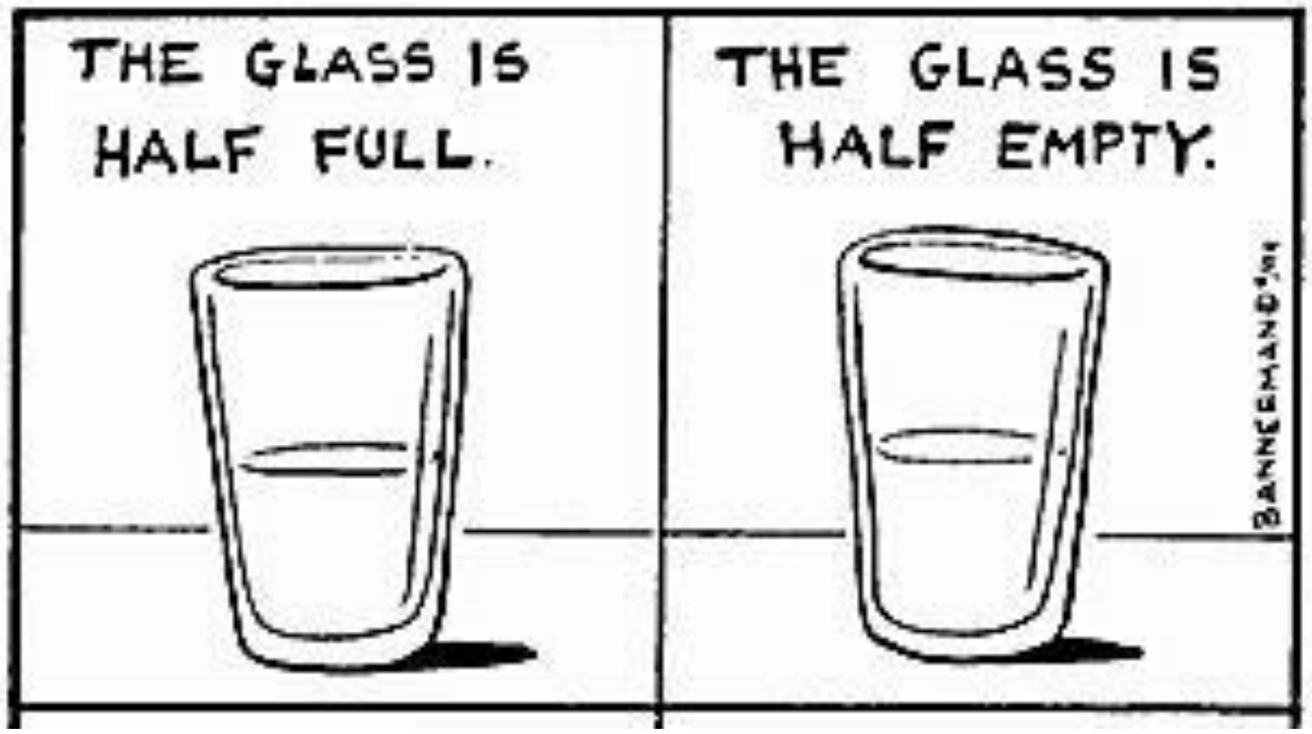
Do we understand this?





We're doing well and we're not out of a job just yet!

We don't understand much and what we thought we knew is possibly wrong!

Three themes to the meeting and programme

- Particle acceleration
- Magnetic field amplification
- Radiative signatures

Will say a little about each...

I Particle acceleration

- Continues to be dominated by DSA (heliosphere supports).
- Impressive advances in PIC simulations, especially for relativistic shocks.
- Dangerous theoretical convergence - are precursors really smooth static structures?

Personally think we need to think much more about what happens if the shock precursors are turbulent, chaotic and possibly intermittent.

Many instabilities, also deceleration in precursor equivalent to effective gravity, strong acceleration at shock injects 'light' CRs - weak analogy with boiling fluid?

Also what about other mechanisms, in particular magnetic reconnection?

But real progress....

2 Magnetic amplification

- On principle, beware band-wagons!
- But theoretically sound and well supported by both observations and simulations.
- However, remember that $\delta B \neq B$!
- Saturation mechanisms? Cascades?

3 Radiative signatures

- Why do we not clearly see shock precursors?
- Where are the Galactic pevatrons?
- What is going on in AGNs and GRBs?
- How do pulsars work?
- Electron heating and acceleration?

Precursor scales are NOT expected to be small.

Age limited proton precursor in SNR,

$$t_{\rm acc} = \frac{3}{U_1 - U_2}(L_1 + L_2) \approx \frac{10 L_1}{U_1}$$

$$t_{\rm acc} \approx t_{\rm dynamical} = \frac{R}{U_1} \implies L \approx R/10$$

NB no assumptions about Bohm diffusion, magnetic field etc in this rather robust estimate:

$$\frac{\Delta R}{R} \approx \frac{1}{10}$$

By contrast, Chandra has arc second resolution, so for a half degree size SNR should be able to resolve features down to scale

$$\frac{\Delta R}{R} \approx \frac{1}{60 \times 30} = \frac{1}{1800}$$

Why do we only have hints of precursors?
How to explain occasional sharp radio rims?
Bipolar morphology in SN1006?

Can we fill in the non-thermal synchrotron spectra between radio and X-ray?

Not to mention....

What controls electron heating in shocks?

Why do the HESS sources turn down a decade before the knee? Where are the pevatrons?

How to explain:

Orphan X-ray flares in AGNs?
Acceleration mechanism in pulsar magnetospheres?
Emission in GRBs?

Conclusions

- Much done, much to do
- Real confrontations between theory and observations on several fronts - good!
- New impetus from powerful computer simulations - but need to be treated with appropriate care and supported by analysis.
- Meeting and Programme was enormously useful in bringing people together with enough time for real and meaningful discussions!

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