LPPFusion Report
March 9, 2021

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Wefunder Capital Campaign First Days

In the first three days of our new Wefunder crowdfunding campaign, we have raised over $80,000 from 64 investors. (Not all investments are visible on the site, due to routine delays in processing larger investments.) This is the first campaign where we have been able to allow unlimited numbers of investors, and the first that we have lowered the minimum investment to a single share, $150.

The investments so far are running at a much faster pace than for our last Wefunder campaign, which started in November, 2019. In that pre-pandemic campaign, $25,000 was raised in the same first three days. So far, most of the increased investment has come from those investing more than the earlier minimum of $1,000. However, we expect the smaller investments to pick up a lot when Wefunder announces our campaign to their over 500,000 investors. We expect that to happen in a few days. Please visit our campaign at https://wefunder.com/lppfusion.

Straight Filaments in the Sky Show Cosmic Connections

Astronomers using the new ASKAP radio telescope announced on Jan. 15 the discovery of an arrow-straight plasma filament stretching across 2 degrees of the sky (four times the apparent size of the Moon in the sky). The filament, (fig. 1), which is 100 times longer than it is wide and is straight to within a few parts per thousand, is a striking enough discovery. But LPPFusion's Chief Scientist Eric Lerner points to the new discovery as evidence linking the ion beams emitted from FF-2B's tiny plasmoids to the Cosmic Microwave Background that pervades the universe. He has included his analysis in a paper now under review at a leading astronomical journal. Our story is a bit long, but we think it's exciting.

The Cosmic Microwave Background (CMB) is a bath of radio radiation that is remarkably smooth and even in all parts of the sky, showing variations only at a level of ten parts per million. Its spectrum—the intensity of the radiation plotted against its frequency—is that of a blackbody, a completely opaque mass, with observation fitting the theoretical spectrum also to within several parts per million. In the Big Bang hypothesis, the CMB is a product of the dense, ultra-hot plasma that resulted from the origin of the universe. Expansion of the universe, in this theory, has cooled the radiation down to a frigid 2.7K above absolute zero. However, in the past five years, and especially since 2019, observations have contradicted all the concrete, quantitative predictions coming from the Big Bang theory of the CMB. This has led to a widely-publicized “crisis in cosmology”.

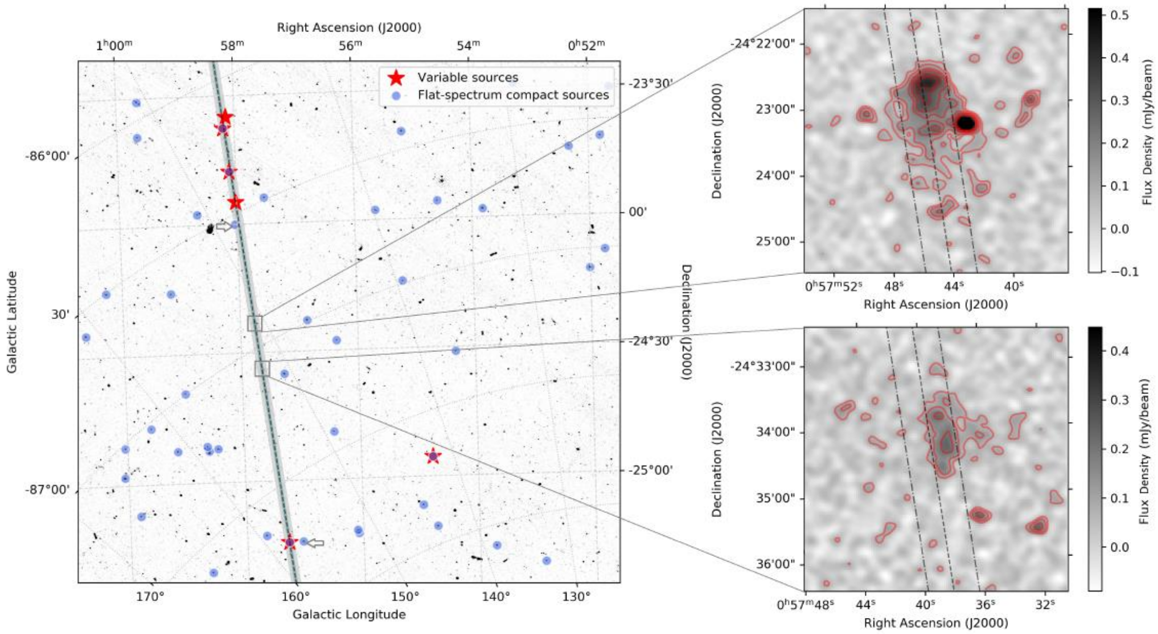

Figure 1. Astronomers have discovered this ultra-straight filament by observing scintillations (twinkling) of five radio sources (red stars). They can see that the filament is thin as the nearby sources (blue dots with arrows) don’t twinkle. Parts of the filament may be dense enough to see directly with their telescopes, as there are two small clouds along the filament line (right-hand images).

There is another explanation for the CMB. Back in the early 1990’s Lerner and colleagues proposed that the energy for the CMB came not from a Big Bang, but from the fusion processes in stars that turned hydrogen into helium. The radiation was smoothed out into a blackbody bath in the present-day universe by a “radio fog” consisting of plasma filaments. These filaments came from powerful ion beams ejected from quasars, active galactic nuclei and Herbig-Haro objects (stars in the process of formation).

Lerner showed how these beams and the hierarchy of filaments they form were vastly scaled-up versions of the beams emitted by plasmoids in the dense plasma focus. (See figure 2 for examples of these filaments.) Indeed, Lerner’s earlier work linking quasars with the plasma focus process formed the theoretical basis of LPPFusion’s Focus Fusion devices. Electrons in the strong magnetic field of the filaments would be able to absorb and re-emit the radio-frequency radiation, scattering it in the observed CMB.

There was observational evidence that something was creating a radio fog. The radio emissions from galaxies got dimmer with distance much faster than their infrared radiation, showing that intergalactic space was not transparent to radio radiation like that in the CMB. But there was no direct evidence in the 1990’s of the filaments Lerner hypothesized. For one thing, the filaments were really hard to see, as they were tiny by astronomical standards. The smallest were only meters across and the largest billions of kilometers—still hundreds of times smaller than the typical plasma clouds stretching across light years.

But now the Australian team has detected filaments that are consistent with the theoretical predictions of 30 years ago. They were not looking for filaments. Instead, they were looking for rapid scintillations, or twinkling, of radio sources. Rapid changes in the intensity of radio emissions—over periods as short as 15 minutes—have long been thought to be due to the motion of the interstellar medium that distant sources are seen through, just as the twinkling of stars is due to the motion of earth’s atmosphere. Searching over a wide part of the sky with the new ASKAP instrument (which consists of an array of three dozen radio telescopes) they found six rapidly scintillating sources.

To their surprise, five of the sources lay along a straight line (fig.1). The only explanation is that they all lay behind the same highly straight filament of plasma.

The fact that the filament is straight to within 0.2 degrees indicates that the internal magnetic forces are at least 300 times stronger than the external ones in the surrounding plasma. In contrast, the gently twisting filaments of objects like the Veil Nebula show that their magnetic fields are only somewhat stronger than those in their environment. The straight filaments are thus analogues to the filaments generated in the beams exiting the plasmoids in a plasma focus. These beams carry ions with millions of electron volts of energy, confined by magnetic fields of tens of MG (mega-Gauss), while the filaments that flow into and form the plasmoids, analogous to the curving ones in the Veil Nebula, are less energetic, with electron energies of thousands of electron volts and magnetic fields less than a MG. The cosmic filaments theoretically predicted in the '90's have ion energies of billions of electron volts.

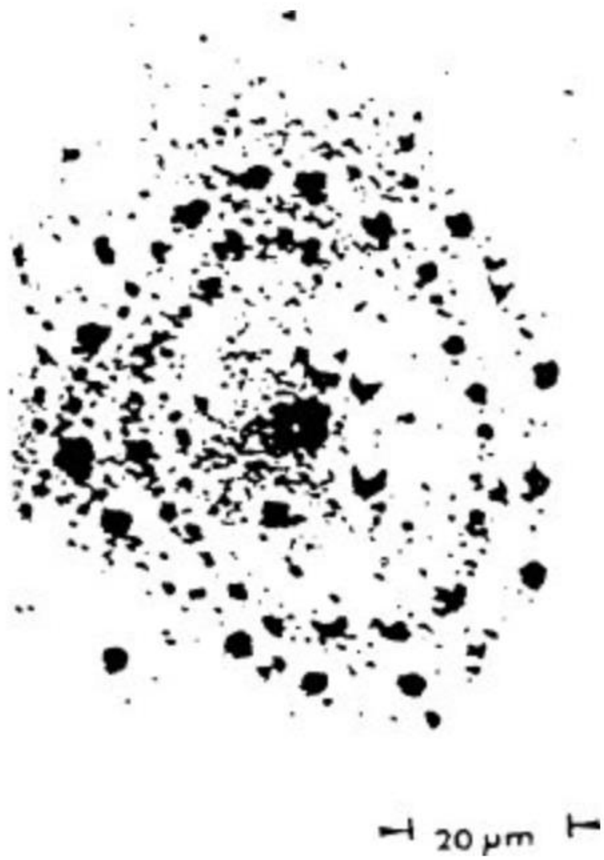

Figure 2. Filaments emitted from a dense plasma focus device form a hierarchy, with the smallest filaments organized into circular layers within larger ones. This image shows the cross sections of the filaments as revealed by a plastic film, where the filament beams impacted, leaving their image. The scale shows that the largest filament is only 30 microns in radius and the smallest only about 1 micron. Filaments in space are organized in similar fractal hierarchies but on much larger scales. Image by Winston Bostick.

But the cosmic filament's straightness, and implied high energy is not the only striking aspect of the new discovery. The researchers concluded that the scintillations observed in the five sources must be caused by very tiny sub-filaments of the straight filament. First, they noticed, observing the scintillations over the course of a year, that the twinkling slowed down in certain months and sped up in others in a smooth way. They figured out this was because the filaments were moving relative to the Sun more slowly than the earth's own 30 km/sec orbital velocity around the Sun. When the Earth's velocity matched that of the filaments, the scintillation slowed down or stopped. When the earth was moving in the opposite direction to the filament, the scintillations sped up. So, the research team could calculate that the filaments were moving about 10 km/sec.

Since the sub-filaments caused 50% or more fluctuations in the sources' radio flux in only 15 minutes, or 900 seconds, the sub filaments radii are only about 900x10 = 9000 km, not much bigger than the earth—extremely small by cosmic standards. Not only that, the researchers were able to estimate the distance to the filaments. They knew the approximate angular size (apparent size in the sky) of the bright radio sources that are twinkling behind the filaments. For the sub-filaments to cause large fluctuations in the radio sources' brightness, the sub-filaments themselves have to be at least as big in angular size. The researchers calculated that the filamentary array has to be within about 10 light years of earth. In galactic terms, practically in our neighborhood. This means that in all probability such filaments are common.

The array of small, energetic filaments observed, Lerner points out, is quantitatively exactly what would be expected from the original theoretical work of three decades ago. Such filaments, scattered through the space between galaxies, would do the job of smoothing the CMB, no Big Bang required.

We can expect to learn a lot more about these filaments in coming months. Researchers using another new radio telescope array, Apertif in the Netherlands, have detected 10 new fast scintillators, at least one of which shows the same tiny filaments. Since the filaments are not so easy to observe in the laboratory either, being only a micron across, quite possibly astronomical observations will help to shed light on FF-2B's beams. Such a back-and-forth flow of results is one of the key features of plasma physics, since plasma phenomena are scale invariant, being very similar on scales from the lab to the cosmos.

Ivy's Dad Dead of Covid

We are sad to report that the father of LPPFusion CIO Ivy Karamitsos has died of Covid. Ljubodrag (Dragan) Zivkovic died in his sleep March 4 after a brief infection. He was 84. Dragan, a retired architect was living in Pancevo, Serbia and was an ardent core supporter of the fusion effort and of Ivy's contributions to it.