October 17, 2022

Dear Colleagues,

We are writing to express our broad support for the science being performed with the LIGO-Virgo-Kagra (LVK) detectors and concern regarding the current schedule for gravitational wave observing runs. The LVK consortium has performed some of the most transformational science in recent memory, and their work has enriched a broad community of scientists beyond that consortium. **We recommend that the LVK commit to extending O4 as long as feasible or until a second electromagnetic counterpart is discovered if no electromagnetic counterpart is discovered in the currently planned duration[1]. We recommend that this commitment be announced immediately so scientists can properly plan for this modification[2].**

The scheduling of observing runs is important to all scientists connected to gravitational wave science. We understand that creating these schedules, including when to start and stop observing runs and the duration of the runs, is complicated and involves many decision points. There must be a balance between many factors, including several that no single community can fully assess. In the spirit of maximizing the science from LVK and to establish a fertile, collegial, and broad community surrounding gravitational wave discoveries, we ask that LVK make some additional considerations when deciding its observing schedule.

We believe that some of the most important and impactful science from LVK can only be achieved by incorporating the work of scientists outside the LVK consortium. In particular, theorists, electromagnetic astrophysicists, and nuclear physicists have significantly enhanced the science already produced by these detectors. Perhaps the best example of this is the multimessenger discovery of GW170817/GRB 170817A/AT 2017gfo[3]. This watershed moment[4], which was recognized as the 2017 Science Breakthrough of the Year[5], dramatically and nearly instantly changed our understanding of several areas across physics from cosmology

[1] We understand that it is impractical for a fully open-ended commitment. A maximum possible duration or a commitment to reassess after a certain amount of time could balance all interests. A metric based on gravitational wave detections of binary neutron star mergers, regardless of electromagnetic counterpart, would also provide more certainty of planning but less certainty of science outcome.

[2] Telescope proposals are submitted up to 2 years before data are taken. Most ground-based telescopes have proposal deadlines 9 months before the end of the observing block. Funding proposals, graduate student thesis planning, and instrumentation projects have even longer lead times.

[3] https://iopscience.iop.org/article/10.3847/2041-8213/aa91c9

[4] https://www.nsf.gov/news/news_summ.jsp?cntn_id=243382

[5] https://vis.sciencemag.org/breakthrough2017/

to stellar evolution to general relativity to nuclear physics. Most of these results required the detection of an electromagnetic counterpart.

The NSF has recognized the value of this cross-disciplinary work; the "Windows on the Universe" is highlighted as one of NSF's 10 Big Ideas[6]. The National Academies Astronomy Decadal Report, *Pathways to Discovery in Astronomy and Astrophysics for the 2020s*[7], lists multi-messenger astronomy as one of the three major themes for the decade ("New Messengers and New Physics"), considers it to be a Priority Science Area, and is the top priority for sustaining space missions.

However, it has been five years since the first and only electromagnetic counterpart was discovered. The O3 observing run, while having many successes, did not yield a second counterpart detection. It will be three years between the end of O3 and the start of O4, further limiting searches for new counterparts. After O3, we now know that the rate of gravitational wave events that have detectable electromagnetic counterparts (i.e., those sufficiently luminous, unobscured by host-galaxy and Milky Way dust, and far from the Sun's position) is low enough that **there is a significant chance that the community will not detect a single counterpart with one year of observing at O4 sensitivity**.

With the current observing plan[8] for O4 lasting one year and O5 not scheduled to start until at least 2026, there is a significant risk that there will not be a second counterpart discovered for at least a decade after the first. Such a long delay will have a particularly negative impact on the field. The gap between electromagnetic counterpart discoveries, which is already the duration of a PhD or multiple postdoc positions, will cause a loss of talent in this area. Junior scientists will struggle to find permanent jobs. NSF-funded electromagnetic observatories will be used inefficiently and future telescope proposal acceptance rates will decline. Funding will possibly be shifted to other fields. Many key areas of gravitational wave science will stagnate.

On the other hand, the exciting science that comes with an electromagnetic counterpart to a LVK discovery will engage a large fraction of the astronomical community and inspire the entire community as well as the public. It will also engage the nuclear and particle astrophysics communities as several studies inspired by the GW170817 have demonstrated that electromagnetic detections are essential for constraining merger dynamics, nucleosynthesis, the maximum mass of neutron stars, and the equation of state of ultra-dense matter. Such a result would continue the goodwill currently expressed by the astronomical community into the future when LIGO is searching for funds for upgrades and when Congress is making funding decisions about next-generation detectors such as Cosmic Explorer – both of which will require broad community backing to be successful.

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[6] https://www.nsf.gov/news/special_reports/big_ideas/universe.jsp

[7] https://nap.nationalacademies.org/catalog/26141/pathways-to-discovery-in-astronomy-and-astrophysics-for-the-2020s

[8] https://observing.docs.ligo.org/plan/ and https://dcc.ligo.org/public/0183/G2201173/010/LVKO4Plan.pdf

To fully enable multi-messenger science and build all related communities, we recommend that the O4 schedule be modified to observe for at least one year (as planned) and if no counterpart is discovered by that point, then continue observing until a second confirmed electromagnetic counterpart is discovered. We also recommend that LVK commits to this plan now so that scientists can properly plan and resources can be appropriately allocated. Such an agreement will build community between gravitational wave, electromagnetic, and nuclear scientists; provide a guarantee to junior scientists who otherwise would be betting on their careers; produce goodwill; and create unique scientific discoveries across several different fields. With a guarantee in place, we can also argue more strongly for more coordination and additional considerations for major, general-purpose facilities such as the Rubin telescope and the Roman Space Telescope as well as two possible NASA missions currently in Phase A (Survey and Time-domain Astrophysical Research Explorer, STAR-X, and UltraViolet EXplorer, UVEX). A unified effort by all related communities to coordinate will allow all to grow and solidify multi-messenger research as a fundamental contributor to science across cosmology, stellar evolution, general relativity, and nuclear physics.

We are eager to search for this counterpart and will devote our available resources to doing this as efficiently as possible so as to make the best use of the limited opportunities. We would happily continue this discussion with LVK to further improve communication between our communities, advise how to best coordinate, and find novel ways to maximize the science from this new scientific field.

Sincerely,

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