

# Detect, Amplify, and Control: Lessons from the 2026 Nobel Prizes for *Low-Dimensional Materials*

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The 2026 Nobel Prizes in Physics, Chemistry, and Physiology or Medicine celebrate three seemingly unrelated achievements: the detection of cosmic neutrinos, the amplification of molecular chirality, and the optical control of neural activity. Yet, viewed through the lens of materials science, they reveal three remarkably complementary principles: detecting weak signals, amplifying subtle differences, and controlling complex systems with precision. These principles offer profound inspiration for the future of low-dimensional materials.

The Nobel Prize in Physics [1], awarded to Francis Halzen for his decisive contributions to the IceCube Neutrino Observatory and the discovery of high-energy astrophysical neutrinos, demonstrates how innovative detection technologies can open entirely new windows into nature. Although IceCube operates on a vastly different length scale, its underlying philosophy resonates with low-dimensional materials research. Graphene, transition metal dichalcogenides, and van der Waals heterostructures offer exceptional opportunities for detecting weak optical and electrical signals through engineered electronic structures and interfaces. The broader lesson is that breakthroughs in fundamental science often depend on breakthroughs in detection capabilities.

The Nobel Prize in Chemistry [2], awarded to Henri B. Kagan and Kenso Soai for nonlinear effects and autocatalysis in asymmetric synthesis, highlights the extraordinary power of symmetry breaking and nonlinear amplification. Their discoveries demonstrate how minute molecular asymmetries can lead to strongly preferred chiral outcomes. For low-dimensional materials, this principle raises intriguing possibilities for controlling structural chirality and selectivity during synthesis. One particularly compelling challenge is the scalable and generalizable chirality-selective growth of single-walled carbon nanotubes with predetermined chiral indices ( $n$ ,  $m$ ). Could chirality-dependent growth kinetics and positive feedback amplify initially small differences in nanotube populations? Although such mechanisms remain to be established, these Nobel-winning concepts provide fresh inspiration for exploring self-selection and symmetry-controlled growth in carbon nanotubes, chiral nanostructures, and twisted two-dimensional systems.

The Nobel Prize in Physiology or Medicine [3], awarded to Karl Deisseroth, Peter Hegemann, and Georg Nagel for discoveries concerning light-gated ion channels and optogenetics, illustrates how light can become a powerful tool for precisely controlling biological activity. Beyond neuroscience, this achievement suggests exciting directions for low-dimensional materials at the interface of electronics, photonics, and biology. Transparent graphene electrodes have already enabled the integration of optical stimulation, imaging, and electrical recording of neural activity. Looking forward, two-dimensional semiconductors, flexible bioelectronic interfaces, and optoelectronic synaptic devices may provide new opportunities for closed-loop neural modulation, brain-machine interfaces, and bioinspired information processing. The challenge is to translate the precision and adaptability of biological systems into reliable, multifunctional material platforms.

Together, these three Nobel Prizes suggest a compelling vision for the field: low-dimensional materials should evolve from passive functional components into intelligent systems capable of sensing, selectively amplifying, and actively responding to their environments. Achieving this vision will require deeper understanding of symmetry, interfaces, nonequilibrium dynamics, and coupled physical, chemical, and biological processes.



As a new journal, *Low-Dimensional Materials* seeks to foster precisely such interdisciplinary advances. We welcome research that not only discovers new materials and phenomena, but also establishes fundamental principles for their controlled synthesis, precise characterization, and functional integration.

The future of low-dimensional materials may ultimately be defined by a simple yet powerful ambition: to detect weak signals, amplify subtle asymmetries, and precisely control complex systems.

### Conflicts of Interest

The author declares no conflict of interest.

### Use of AI and AI-Assisted Technologies

During the preparation of this work, the author used ChatGPT to generate the draft. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

### References

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2. Available online: <https://www.nobelprize.org/prizes/chemistry/2026/press-release> (accessed on 12 October 2026).
3. Available online: <https://www.nobelprize.org/prizes/medicine/2026/press-release> (accessed on 12 October 2026).