

Roman Jackiw and the chiral anomaly

The morning after Roman Jackiw died on 14 June 2023, his widow, So-Young Pi, wrote to inform me, and I replied to her, “Roman left a great legacy of discoveries to the physics world, which are widely admired and appreciated, and which you shared in in his later years.” I have since been surprised, and dismayed, to see old controversies resurfacing about the history of the chiral anomaly, a quantization-induced breaking of classical axial symmetry.

To appreciate Roman’s legacy, it is not necessary to rewrite the history of the chiral anomaly, as Andrew Strominger does in his obituary on page 53 of the December 2023 issue of *PHYSICS TODAY*. Strominger writes, “Famously, as a young postdoc working with John Bell at Harvard, Jackiw discovered the so-called Adler-Bell-Jackiw axial anomaly and used it to explain the decay of pions into photons. He turned lemons into lemonade by both interpreting and making physical predictions from what seemed to be an inconsistency in the Feynman diagrams.” As I wrote to Strominger in response, the original Bell-Jackiw article¹ does not give a correct calculation of neutral pion decay into photons; it introduces a spurious regulator. The correct calculation was first given in my article finding the chiral anomaly, in the appendix I added after I learned of the Bell-Jackiw work.²

When I sent my draft appendix to Roman, he replied in a letter dated 25 August 1968, expressing skepticism that an unambiguous calculation of pion decay to photons was possible using the chiral anomaly, which he characterized as beset

with intrinsic mathematical ambiguity. More to the point, and very candidly, John Bell wrote in a letter dated 2 September 1968, “The general idea of adding some quadratic electromagnetic terms to PCAC [the partially conserved axial current] has been in our minds since Sutherland’s η problem. We did not see what to do with it.” The originals of those letters reside in the Institute for Advanced Study Archives and can be viewed there by researchers in the history and philosophy of science.

Further detail on the history of the chiral anomaly is contained in my 2006 volume of commentaries and selected papers.³ I consider the correct calculation of pion decay to photons to be the result of a fruitful scientific interaction between the Bell-Jackiw work and my own. I hope that people who are interested in the subject of anomalies will read (or reread) the original papers.

References

1. J. S. Bell, R. Jackiw, *Nuovo Cimento* **60**, 47 (1969).
2. S. L. Adler, *Phys. Rev.* **177**, 2426 (1969).
3. S. L. Adler, *Adventures in Theoretical Physics: Selected Papers with Commentaries*, World Scientific (2006).

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► **Strominger replies:** Stephen Adler has an incredible scientific legacy, including his central role in work on the chiral anomaly and beyond. To quote his letter, I “consider the correct calculation of pion decay to photons to be the result of a fruitful scientific interaction between the Bell-Jackiw work and [his] own.” I also follow Adler in urging everyone to read the original papers.

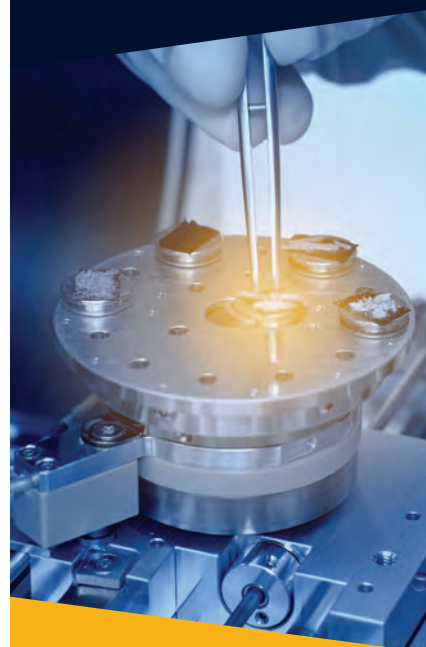
In the very limited space I was allotted to cover the rich life and works of Roman Jackiw, I did not attempt to focus on scientific accomplishments beyond his own or to write a comprehensive history of others’ contributions to developments he was involved in. I presumed that that would be understood and that my words would not be taken to diminish the significance of those contributions. I apologize for any misunderstandings in that regard.

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