PROCEEDINGS OF SCIENCE

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# Unsung heros of science

**Graham Garland Ross (1944–2021)**





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The annual Corfu Summer Institute has now been going on for four decades, with the help and encouragement of numerous people from across the world. Among its staunchest long-time supporters has been the Scottish theoretical physicist Graham Ross who was a pillar of the Particle Theory Group in the Rudolf Peierls Centre for Theoretical Physics at the University of Oxford. Last November we were shocked to learn of his passing from a sudden heart attack at the age of 77. The Proceedings of the "Standard Model and Beyond" Workshop[1] at the 21st Summer Institute are hereby dedicated to Graham who was a close friend to many of us, a brilliant physicist who made many fundamental breakthroughs, a highly respected colleague, and a wonderful man.

An obituary of Graham by his long-standing collaborators John Ellis & Frank Close and one of us has been published in CERN Courier, and a more detailed account of his scientific accomplishments will appear in the Biographical Memoirs of the Royal Society. What follows are brief personal reminiscences of Graham from two of us who were privileged to work with him for many years — one of us (DG) as initially his DPhil student, and the other (SS) as his junior colleague.

Every October when the new Oxford graduate students arrived, rumour had it that you would have to be really lucky for Graham to accept you as his DPhil (PhD) student. But if he did, it would guarantee you a great experience! Graham's office door was always open to students, who he would welcome in with a cheerful smile, ready to listen patiently before asking just the right questions. He regarded them as equal collaborators on a most important project, despite the obvious differences in experience and knowledge. This respect gave them confidence to continue their work through to a thorough understanding of the subject, which Graham shared with them with patience.

Working with Graham was a great experience: his insight was deep & original, with a thorough and rigorous approach at the same time, coming from an enthusiasm for research and life in general that was contagious and inspired many of us in difficult times. Add to this his warm presence, cheerful smile and good humour, all of which made working with him a great experience and Oxford a very special place to be. This was particularly evident when Graham retired in 2011 and a GrahamFest was organised (in great secrecy ... otherwise he would have certainly bolted to Australia!) at which many of his close collaborators and ex-postdocs & students spoke in his honour. It was an unforgettable occasion, full of warmth and laughter and the shared esoteric culture of theoretical high energy physics — a delightful reminder of why we do what we do.

In today's competitive world of research, many scientists aggressively promote their latest work, even before it is published, seeking fame, recognition & reward. Although competitive himself in a sporting sense, Graham was just the opposite of that. He was among the shrinking number of 'gentlemen' in our academic world, who delighted simply in the pleasure of finding things out as his erstwhile colleague Richard Feynman put it. Graham would listen patiently and provide a deep insight into a scientific problem to any researcher. If you had an idea that you might be concerned was a bit too strange, Graham was the best person to ask ... even if it turned out to be wrong, he would always find something interesting and constructive to say about it. In seminars and at conferences Graham questioned every speaker — which certainly some less experienced researchers initially found rather scary, before coming to appreciate that Graham simply wanted to understand the essence of they were talking about and help them to do the same.

[1] The last Workshop Graham attended and gave a talk at was during Corfu 2019.

Only after his retirement, Graham was recognised by the UK Institute of Physics with the award of the Dirac Medal for "his theoretical work in developing both the Standard Model of fundamental particles and forces and theories beyond the Standard Model that have led to many new insights into the origins and nature of the universe."[2] Our title reflects the generous tribute to him ("Quarks and gluons with an unsung hero: Professor Graham Ross") by the IoP: "A powerhouse of physics, and one of the UK's best kept secrets, Graham laid out the pathway to the discovery of the gluon, the force carrier for the strong nuclear force, and taught Richard Feynman how quantum chromodynamics could be used to work out the interactions between quarks and gluons".

Graham was elected a Fellow of the Royal Society in 1991 but he was not the first scientist in his family to receive such an honour. Garland, his grandfather, had been elected a fellow of the Chemical Society (the forerunner to the Royal Society of Chemistry) in 1913; he received a grant of £10 to research ancient Egyptian alloys, being among the first to study the crystalline structures of ancient metals. [3] Few have heard however about Major Herbert Garland, "Garland of Arabia", the scientist turned soldier, who was the unsung hero [4] behind the successful campaign of Lawrence of Arabia; [5] he was a "maverick explosives expert" and a mentor to Lawrence who he taught how to employ dynamite (which funds the Nobel prize!) in the Arab insurgency against the Ottoman Empire during the First World War. Lawrence described Garland thus: "[he was] an enquirer in physics and had years of practical experience of explosives... sappers handled it like a sacrament, but Garland would shovel a handful of detonators into his pocket with a string of primers, fuse and fusees and jump gaily on his camel for a week's ride to the Hejaz Railway". Yet Garland (who reminds us of Graham!) has largely been forgotten in the wake of his more famous brother-in-arms.

Among Graham's many influential research papers his work with John Ellis & Mary K. Gaillard, with the title "Search for gluons in $e^+e^-$ annihilation" (1976) is undoubtedly seminal; it predicted the "Mercedes" events with three-jets, one of them due to hard gluon radiation (by final state quarks) which then generates a jet similar to a quark jet. This paper outlined clearly the optimal strategy for the experiments which were performed in 1979 at the PETRA collider at DESY, Hamburg. It is the second gauge boson to have been discovered experimentally (after the photon) and the first force carrier of a non-Abelian confining gauge interaction. Rather belatedly, the 1995 EPS High Energy & Particle Physics Prize has been awarded to Paul Söding, Björn Wiik, Günther Wolf & Sau Lan Wu, "for finding the first evidence for three-jet events in $e^+e^-$ collisions" while working with the TASSO Collaboration. A Special EPS Prize was also awarded to the JADE, MARK-J, PLUTO & TASSO Collaborations whose results independently confirmed the gluons existence. It is only appropriate that the pioneering theorists who made this discovery possible should also be recognised, even though in the case of Graham any award would now be posthumous.

A special 'Graham Day' will be organised during the 2022 Corfu Institute on 1 September to pay homage to our dear departed colleague and friend — he will not be forgotten.

**Dumitru Ghilencea & Subir Sarkar**

[2] Institute of Physics UK, Paul Dirac Medal and Prize recipients

[3] Wikipedia: Herbert_Garland.

[4] Royal Society of Chemistry: "The forgotten scientist who trained TE Lawrence behind enemy lines".

[5] T.E. Lawrence, *Seven pillars of Wisdom and the evolution of a Revolt*, Lawrence of Arabia's account and memoires of the Arab revolt and guerrilla warfare during World War 1, published by Musaicum Books, ISBN 978-80-7583-651-9