A Note on the History of HERWIG

I was at CERN on sabbatical leave from Cambridge for the academic year 1982-83. That was where I first met Pino Marchesini and we began our long collaboration on the Monte Carlo event generator that became HERWIG, as well as on many other topics in QCD. Pino had been working on soft gluon coherence effects with Antonio Bassetto, Marcello Ciafaloni and Al Mueller. They had found that multiple soft gluon emission was angular ordered (also discovered independently by Boris Ermolaev and Victor Fadin), and we decided to write a Monte Carlo parton shower program including this feature. At that stage it was just a gluon shower which we compared with various analytical predictions. This resulted in the paper [1], which was submitted for publication in March, 1983, but didn't appear in the journal until May 1984. This was because a referee kept insisting that the paper must be wrong because the shower didn't fill the whole kinematical phase space, whereas the whole point was that the regions of disordered emission were empty due to destructive interference.

Pino went back to Parma early in 1983 while I stayed on at CERN until the end of the year, developing a cluster hadronization model based on the preconfinement of colour discovered by Daniele Amati and Gabriele Veneziano. By adding quarks to the angular-ordered shower, I could match it to the hadronization model and make some first comparisons with jet data [2].

The results were sufficiently promising that Pino and I decided to rewrite the code in a more modular form and use it as the basis for a complete event generator for QCD processes in lepton-lepton, lepton-hadron and hadron-hadron collisions. This took us about four years. A major part of the work was the development of an efficient spacelike parton shower with QCD coherence for processes with initial-state hadrons. A model for soft collisions and the underlying event in hadron-hadron processes was included, based on that developed by David Ward at Cambridge for the CERN UA5 collaboration. This was used to formulate widely-adopted tests of underlying event properties in jet production [3]. We also worked with Keith Ellis on establishing the initial conditions for parton showers attached to general QCD hard scattering processes [4]. The resulting program was called HERWIG [5], for Hadron Emission Reactions With Interfering Gluons, also as a humorous tribute to Herwig Schopper, then Director General of CERN.

Over the next few years the program began to be used by the experi-

mental collaborations at the CERN SPS proton-antiproton collider, at the DESY HERA electron-proton collider, and at LEP for comparison with their data and for modelling backgrounds for new physics searches. There was always a friendly rivalry with the Pythia event generator, developed mainly by Torbjorn Sjöstrand at Lund for similar purposes using a different parton shower formulation and the Lund string model of hadronization. Unwisely, the experimenters often took the difference between the HERWIG and Pythia predictions as a measure of systematic Monte Carlo uncertainty.

Theoretical development of the program continued, including treatment of soft gluon coherence in heavy quark processes [6], spin correlations in the shower using a method proposed by John Collins and implemented by my student Ian Knowles, and, with Stefano Catani, the so-called CMW scheme [7] for improving precision at high x. By 1992 we had assembled a small collaboration and produced a users' manual for HERWIG version 5 [8], which now has well over 2000 citations. The range of processes included, and the size of the collaboration, continued to grow, the next major milestone being the inclusion of supersymmetric processes by Stefano Moretti and my student Kosuke Odagiri, with the associated publication in JHEP [9] (now with over 3400 citations).

The HERWIG Fortran code was becoming difficult to manage, and Fortran was falling out of favour with the HEP community, so in 2001 it was decided to rewrite the program in C++. I wanted to call the new program LUDWIG, in tribute to Beethoven, but this was not a convincing acronym and it became simply Herwig++ [10]. By this stage Pino was a consultant but not an author. I continued to contribute ideas, without being allowed to touch the code as my C++ skills were inadequate, until the release of the definitive Herwig++ manual [11] (currently over 2000 citations). By 2016 the program had become Herwig 7 [12] and I was no longer involved. The project is now in the very capable hands of Mike Seymour, Peter Richardson, Stefan Gieseke, Simon Plätzer and their post-docs and students. It is used by all the major LHC experiments and remains at the forefront of event generator development.

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