PREFACE

Recent advances in AdS/CFT integrability

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Preface

Recent advances in AdS/CFT integrability

Integrability has long played a fascinating role in the theoretical exploration of classical and quantum models. Over the last two decades, this was applied with remarkable success to unveiling the structure of certain gauge and string theories and their relation through the AdS/CFT correspondence. Integrability first emerged in the context of the holographic duality between $\mathcal{N} = 4$ supersymmetric Yang–Mills theory (SYM) and strings in $AdS_5 \times S^5$, proving particularly fruitful and adding to the hope that integrable methods may be useful in solving non-trivial examples of higher dimensional field theories. The description of the exact spectrum of planar anomalous dimensions in $\mathcal{N} = 4$ SYM is a particularly striking example of the power of integrability-based methods to provide insight into non-perturbative regimes of (conformal) gauge theories. These theories display a much richer structure than most previously-studied exactly solvable theories, such as e.g. minimal models, Wess–Zumino–Novikov–Witten models, or two-dimensional relativistic integrable models.

Research in AdS/CFT integrability continues to be very active, addressing an ever wider range of physical observables, extending integrable methods to different theories and developing novel mathematical techniques. This activity necessitates up-to-date reviews and pedagogical introductions to the state-of-the-art which is the goal of this special issue.

The topics covered in this issue are all the focus of ongoing research and, in addition to their individual interest, underline both the depth and breadth of this subject. They are:

(a) The deep connection between quantum integrable models and the theory of ordinary differential equations, the ODE/IM correspondence, and the application to the theory of embedded surfaces in higher-dimensional manifolds by Patrick E Dorey, Clare Dunning, Stefano Negro and Roberto Tateo.

(b) The computation of one-point functions in defect conformal field theories by means of integrable spin-chain methods by Marius de Leeuw.

(c) The use of classical integrability to compute semi-classical three-point functions of strings in AdS spaces by Shota Komatsu.

(d) The application of integrable methods to compute Wilson loops in $\mathcal{N} = 4$ SYM theory by Hagen Münkler.

(e) The AdS/CFT 'quantum spectral curve', which is a new powerful method for the exact computation of planar anomalous dimensions in $\mathcal{N} = 4$ SYM by means of a Riemann–Hilbert problem by Fedor Levkovich–Maslyuk.

(f) Four dimensional $\mathcal{N} = 2$ super-conformal field theories, their representation theory and the construction of spin chains for the computation of anomalous dimensions by Elli Pomoni.

The origin of most of these articles was in a series of lectures presented over the course of two schools held in Trinity College Dublin from February 27th to March 3rd, 2017, and in Monte Verità, Ascona from January 7th to January 13th, 2018 aimed at MSc/PhD students and early stage postdoctoral researchers. These events were part of the 'Young Researchers Integrability School' series which began at Durham University in 2015. That first edition provided an introduction to topics in integrability such as Yangian symmetry, coordinate and algebraic Bethe ansatz, and integrable structures in CFT. The lectures from the Durham school were also

collected into a special issue for Journal of Physics A, which has since become an invaluable reference for researchers working in this area. There were of course topics not covered in those initial lectures and there have been many interesting subsequent developments. It was the goal of succeeding schools to cover some of these topics and hopefully this collection will act as an equally useful reference for the material reviewed in this issue.

We would like to thank all the authors for their work in preparing and presenting their original lectures and for their pains in carefully writing these contributions. We would also like to thank the schools' participants for their feedback on the material presented. Finally, we would like to thank the editorial staff of the journal, in particular Rebecca Gillan and Eimear O'Callaghan, for all their work in preparing this issue.

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