

Preface

In this book I want to tell the story of gauge fields, the messengers that transmit signals among elementary particles, enabling them to interact. They work in the quantum realm of quarks, the deepest level of the structure of matter we have reached so far.

The basic interaction at this level percolates upwards, through hierarchies of organizations, to the everyday world we live in.

On its way, the interaction appears in different guises — nuclear interaction, atomic interaction, and the classical electromagnetic interaction that rules our everyday world. But these are facets of the same basic interaction.

The idea of “gauge” first appeared in electromagnetism. At the level we speak of, however, it is inextricably tied with the “quantum phase”, that abstract attribute that distinguishes the microscopic world from the macroscopic, and that, incidentally, empowers new technologies of the 21st century, such as atom lasers and quantum computing.

The story of gauge fields is the story of our quest for the fundamental law of the physical world. It is the story of theoretical physics, from the time when Newton defined the meaning of force through his law of motion. To tell the story, we have to start from that beginning, for the thread is continuous and unbroken.

This book is not about the history of gauge theory, however. Our main goal is to introduce the idea behind gauge theory. We cover people and events relevant to gauge theory; but the order of narration follows ideas, rather than history.

Theoretical physics has given us a *true* understanding of the physical world. To quantify its achievement, we only have to note that theory agrees with experiment to one part in a trillion, in the most up-to-date measurement of the electron's magnetic moment.

Our greatest wonderment is to be reserved for the fact that our theories are not only true, but also beautiful. Theoretical physics is truly blessed, in that the quests for truth and beauty coincide. At the end of the book, we draw on what we have learned to offer a possible explanation of this remarkable coincidence.

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