PART I

Preliminaries

Introduction

Few books have more splendidly informative titles than Theon of Smyrna's *Mathematics useful for reading Plato*. A title modelled on his, perhaps *Harmonic theory useful for reading classical Greek philosophy and other things* would have given a fair impression of my agenda here. But that's a little cumbersome; and for accuracy's sake, I would have had to tack the phrase '*and indications of the converse*' onto the Theonian title, since I shall be trying to show not only how harmonics can be 'useful' to students of other fields, but also how the preoccupations of Greek writers who tilled those fields can shed light on the development of harmonics itself, and can help us to understand its methods and priorities. More importantly, this hypothetical title would have been dangerously hubristic; it has the air of presupposing a positive answer to one of the book's most serious questions. Leaving one or two exceptional passages aside (the construction of the World-Soul in Plato's *Timaeus*, for example), does a knowledge of the specialised science of harmonics, and of its historical development, really give much help in the interpretation of texts more central to the scientific and philosophical tradition, or in understanding the colourful environment inhabited by real Greek musicians and their audiences, or indeed in connection with anything else at all? Can such knowledge be 'useful', and if so, in which contexts, and how? I intend to argue that it can, though not always in the places where one would most naturally expect it.

There is a point I should like to clarify before we begin, to avoid misunderstandings and to help explain some of this book's unavoidable limitations. Specialists in the ancient musical sciences may be few (though there are many more swimmers in these tricky waters now than there were when I took my first plunge over twenty-five years ago); but they are nevertheless various. By and large, they fall into two main groups. Some are professional musicologists, who may have worked their way upstream into these reaches from a starting point in the Middle Ages or the Renaissance. Others set out from a training in Classics, within which broad church I include

devotees of ancient philosophy and science. Musicologists, of course, are sometimes proficient in Greek and Latin, and some classicists are excellent musicians; but when tackling their professional work, each group brings to it the equipment, the presuppositions and the puzzlements of their own academic tribe. I am no exception, and I make no bones about the fact. I am a classicist and a student of Greek science and philosophy. As it happens, I have made a good deal of music in my time, but I am not a trained musicologist. American colleagues have sometimes chided me, no doubt rightly, for my lack of a properly musicological perspective. So be it; each of us does what he or she can.

Most work published nowadays in this field is written by specialists for specialists. From time to time, over the years, I have contributed my own penny-worth to these esoteric conversations; but I have always had another objective in mind. Like the other branches of ancient 'musical theory' (and indeed all other serious forms of enquiry), harmonics was not a water-tight, self-contained enterprise, ring-fenced from its cultural and intellectual surroundings. In some of its guises it drew extensively on the concepts, methods and doctrines of other fields of intellectual study, and fed them, in turn, with its own; in others, or so I shall argue, its relations with philosophy and the natural sciences are more distant and its interactions with real-world music-making and musical appreciation much closer than is often supposed. Its exponents wrote and taught in ways, and for purposes, that responded to the wider controversies of the day, and to the specific intellectual, cultural and educational demands of their environment. Most of the authors I shall consider in this book did not compose free-standing treatises on musical topics, but pursued the subject as an element in some other philosophical, literary, scientific or artistic enterprise. Even when these external points of reference are put aside, experience with my own students has convinced me that one does not need an unusually eccentric turn of mind to find harmonic theory as delightfully fascinating in its own right as any other discipline, once one has been lured into the labyrinth. In other publications, and in lectures and seminars here and there around the globe, I have therefore tried to find ways of advertising its charms to people who work in other, intersecting areas, to musicians, to mathematicians, to classicists in general, and especially to students of ancient philosophy and science, and I shall continue with that attempt in this book. I hope that the musicological cognoscenti will find things in it to interest and perhaps to infuriate them, but I would like to show others as well that forays into this little jungle will not be a waste of their time.

This will involve a delicate balancing act between intricacies of detail and the larger perspective; no doubt from time to time I shall fall off the tight-rope on one side or the other. Too bland and generalised an approach would disguise the subject's intellectual meat and sophistication; equally, I do not want to face readers with impenetrable thickets of minutiae. The writer of a book of this sort must also decide whether the science's content and its contexts should be allowed to intermingle, enriching and informing one another in a seamless exposition, or should be addressed in separate compartments for the sake of clarity. I have adopted a mixed strategy; some chapters are principally concerned with one or the other, and in others, for various reasons which I hope will become apparent, I have done my best to weave the two together. But of course the division is thoroughly artificial. The internal agenda that drove the discipline's development was in many cases a response to pressures from outside its borders, and one can make little sense of its changes by considering it in isolation. The separate chapters on 'contexts' are not just titbits for non-specialists. Neither should the more technical parts of the book be treated as if they were labelled 'For Experts Only'. Each depends on the other. Anyone who pursues the history of Greek harmonics beyond the period covered here will find that in later times the situation is even more acute. The story spans more than a thousand years; and though significant developments in the methods and doctrines of harmonic theorists are confined, with some minor and a very few major exceptions, within the compass of its first two centuries, that is not to say that nothing happened for the rest of the millennium. A great deal did. But the history of changes in those later centuries is to a large extent a history of shifting contexts. It is a story about the ways in which inherited ideas were used, abused, recombined and inserted into new settings, new forms of discussion and new patterns of enquiry. In the earlier period, while the discipline was inventing itself, there is much more to be said about its internal debates and transformations, but processes of the sort which take the limelight later were crucially involved from the start.

Greek harmonics in general, and in this period in particular, is not the easiest of topics. This is not only, or even principally, because it involves esoteric technicalities. The most obstructive difficulty is one that it shares with other, more familiar fields of study, Presocratic philosophy for instance; no extensive texts on the subject survive from the fifth century and very few from the fourth, and much of its history has to be reconstructed out of fragments and reports embedded in other people's writings, of various

kinds and dates. By no means all the evidence we have can be taken at face value. Later reports and even contemporary ones are commonly coloured or distorted by their authors' own agendas; some are plainly anachronistic or otherwise inaccurate; a considerable number are bare-faced fictions. This does not mean that the project is impossible. Modern studies in other areas affected by these problems have done a great deal to illuminate them and to show how they can, to some extent, be resolved; and harmonics and its history are now much better understood and more widely known than they were twenty-five years ago. But a great deal remains to be done, both in interpreting the theorists' work and (still more) in unravelling its contexts, and again in trying to communicate the significance of sometimes arcane researches to a wider readership.

THE AGENDA OF GREEK HARMONICS

Non-specialist readers will be getting impatient with my repeated and unexplained references to 'harmonics'. It is high time I said something to explain what the subject is. It is one of three sister-sciences which share a strong family resemblance; the others are rhythmics and metrics.[1] They deal, plainly enough, with different aspects of the subject. But each, in its own sphere, has a similar goal: it is to identify, classify and describe, with the maximum of objectivity and clarity, the regular and repeated patterns of form and structure which underlie the bewildering diversity of melodic, rhythmic or metrical sequences found in musical compositions themselves. Metrics studies the patterns formed by the lengths of syllables in verse, whether or not it is set to 'music' in our sense of the word. I shall say little about it here; all students of Greek poetry in its literary guise are already familiar with it, and its mysteries have been expounded, time and again, by scholars much better qualified in its black arts than I am. Rhythmics (when it is distinguished from metrics, which is not always the case either in ancient or in modern treatments[2]) is a more strictly 'musical' discipline. It examines the patterns within which, when poetry becomes song (or when purely

[1] The names of the three sciences appear first in fourth-century sources. Harmonics is *ta harmonika* at Plato, *Phaedrus* 268e6 (the *Republic* identifies it only by reference to its subject-matter, *harmonia*, 531a1), *harmonikē* in several passages of Aristotle, e.g. *Metaph.* 997b21, and often in later writers; rhythmics is *rhythmikē* at Aristox. *El. harm.* 32.7, where it is distinguished from *harmonikē*, *metrikē* and *organikē* (the study of instruments); Aristotle had earlier referred to metrics as *ta metrika* and *metrikē* at *Poetics* 1456b34, 38.

[2] Plato, for example, rarely marks a clear distinction between metre and rhythm; but for explicit instances of the three-part classification which later became common, see *Gorg.* 502c5–6, *Rep.* 601a8. There is an earlier indication of it at Aristoph. *Clouds* 635–50.

instrumental music is in question), the singers' sequences of long and short syllables (or the instrument's sequences of long and short notes) are divided and grouped into repeated rhythmical structures, not necessarily identical with metrical 'feet' and analysed rather differently, and roughly analogous to the 'bars' of more modern music. This form of enquiry will make occasional appearances in this book, but only fitfully and in a supporting role. Composers themselves, of course, may well have found that its analyses were sometimes helpful to them in the practice of their craft, and it is true that its findings sometimes surface in the work of philosophers, scientists and other non-musical writers. In the period we are considering, however, they do so less frequently and less significantly than those of harmonics; it is harmonics, out of the three central musical disciplines, that lives the most vigorous life outside its own specialised sphere, and interacts most intimately with patterns of thought characteristic of other intellectual domains. Greek writers themselves commonly take the view that harmonics is the first and most important of the musical sciences, whereas rhythmics becomes visible to us as a substantial discipline, and one into which serious philosophical issues have been absorbed, in the surviving work of only one author.[3]

The other essential ingredient of all Greek music, alongside rhythm, was melody; and it is the structures underlying melody that are the concern of harmonics. 'Harmony' and 'harmonic progression', as we understand such things, had no place in Greek musical practice, and the concepts would have meant nothing to their theorists.[4] Any sequence of sounds recognisable as a melody depends for its musical coherence on a pattern of relations between the notes and intervals on which it draws, one that can be set out, formally and abstractly, as a scale of some specific type (or, in more complex cases, as a combination of two or more such scales). More concretely, when a Greek lyre-player set out to play a melody, it was essential that the strings of his instrument were already tuned to a pattern of intervals which would make such a melody possible. But from the perspective of most Greek theorists, though perhaps not all, this puts the relation between melody and

[3] The author is Aristoxenus; the remnants of his work in rhythmics and other pieces of evidence about it are collected and discussed in Pearson 1990. Two other disciplines will be discussed from time to time in our reflections on harmonics itself, as distinct from its contexts. One is mathematics, especially the branch of it known as *arithmētikē* or 'number-theory'. The other is physical acoustics, a science of broader scope than harmonics since it deals with sounds in general, not only those relevant to music. But it seems to have originated as an accessory to one form of harmonic research, and will be considered here only in that role.

[4] In practical music-making, accompanists sometimes – perhaps often – played notes other than those currently sounding in the melodic line. But we know all too little of this practice, and there are few traces of Greek attempts to study it from a theoretical point of view. For further discussion see Barker 1995.

attunement the wrong way round. In their view the status of a sequence of notes as a genuine melody depends on its being rooted in a scale or attunement which is itself formed in a properly musical way.[5] Melodies are infinitely various, but the structures from which they draw their musical credentials are not. Not just any arrangement of notes and intervals can form the basis of a melody, and according to the Greek theorists those that can do so can be sharply distinguished from those that cannot. The central task to which they set themselves was to identify and analyse the varieties of scale and the systems of attunement which could be reckoned as musical, and which could transmit their musicality to melodies constructed on their foundations.

Put like this, the harmonic theorists' project may seem simple, even trivial. Our melodies, by and large, are built either on a major or on a minor scale (with one or two variants), and a seven-year-old child can learn to describe them. But even before other complexities arise, as they will, there are at least two reasons why the Greek theorists' task was more demanding than the modern analogy suggests. First, as is well known, the Greeks used many more types of scale than we do, and included among their elements a much more various repertoire of intervals than our scales contain, restricted as they are to permutations of the tone and the semitone. Tiny differences between the intervals used in two scales – the difference, for instance, between a quarter-tone and one third of a tone – might mark the borderline between radically distinct musical systems, credited with strongly contrasting aesthetic properties. Other differences, equally small, could amount – or so the theorists assure us – to the distinction between a musically acceptable scale and a meaningless and melodically useless jumble of noises. Much larger differences, in certain contexts, were construed as generating no more than variants of the same type of scale. The theorists, furthermore, were far from unanimous in their analyses of the various scale-systems they considered. This is evidently a much more intricate field of study than we might initially have suspected.

Secondly, we should not underestimate the importance of the fact that in the fifth century this enterprise was entirely new. Musicians, of course, were

[5] Scales differ from attunements in two principal ways. A scale is a series of notes set out in order of pitch, while an instrument's strings need not always be arranged with the highest note at one end and the lowest at the other, and the remainder set out in pitch-order between them. Secondly, to think of a set of notes as a scale is to think of it as a sequence of steps, unfolding successively in time; an attunement is simply a structure or pattern, in which no element is temporally prior to any other. In some Greek approaches it is attunements and in others it is scales that are the main focus of attention, and sometimes at least there are philosophically and musically interesting reasons for their difference in emphasis. But these distinctions and complications need not yet concern us.

familiar with the systems they used; they could recognise the distinctions between one pattern of attunement and another, and could construct them in practice. But there is a world of difference between the capacity to recognise, create and use a system of notes and intervals, and the capacity to analyse and describe it in clear and objective terms. There is no evidence to suggest that musicians of the earlier period had a vocabulary of the sort that such descriptions demand, or even that they thought of the relations between elements of their systems in ways that could, even in principle, be made 'precise' in anything like a scientific sense. When theorists began to tackle the task, most of them (perhaps not quite all) took the view that it could be achieved only if the relations between notes could somehow be represented quantitatively, and measured; no other approach would allow the intervals in each scale or attunement to be precisely specified and compared in a way that the mind could grasp. That is all very well; but how are musical intervals to be measured? No appropriate metric existed. It had to be invented from scratch (in fact two quite different methods of measurement were devised, as we shall see in Chapter 1); and there were difficult obstacles to be negotiated both in the invention of any such metric and in its application to the musical phenomena.

Once the harmonic enterprise was well under way, in at least two quite different forms, the theorists began to engage with issues of more complex and abstract sorts. Given that there are many different scales, are they related to one another in an intelligible way? Are all scales that span (let us say) an octave or more constituted out of sub-systems of identical or analogous types, and if so, are there constraints on the ways in which these sub-systems can be combined? Are there orderly procedures which permit the transformation of one kind of scale into another? Is it possible to identify all the musical systems there can be, and to show that the tally is complete? Given that the two approaches to measurement I have mentioned formed the basis of enquiries which differed quite radically in their methods and results, what grounds were there for preferring one or the other? Most crucially of all, are all the schemes of relations which harmonics identifies unified and governed by some fundamental principle or some coherent group of principles, so that all structures conforming to those principles, and no others, are thereby constituted as properly musical? If so, what kinds of principle are involved? What gives them their authority? Are they somehow rooted in human nature, or in the nature of something independent of humanity, or in mathematics, or are they merely products of social convention and tradition? Are they peculiar to the musical sphere, or do they have wider application?

Questions of these sorts are first raised explicitly by fourth-century writers. They answer them in various ways, but in one fundamental respect they are unanimous. Greek musicians, as I have said, used a number of different kinds of scale and attunement, considerably more than are familiar to most modern 'Western' ears, and there were ways in which they could be varied, transformed and combined with one another. Greek musical historians commonly credit this or that composer with having pioneered some new variety of scale. But it is axiomatic for all the theoretical writers whose views can be clearly pinned down that there is an objective and discernible line of demarcation, independent of human whim, decision or ingenuity, between musically well-ordered relations and transformations on the one hand, and on the other the indeterminate chaos of the non-musical. The distinction is not one of convention or taste, but is somehow fixed in the order of things, awaiting discovery, and from this perspective the innovative composers discussed by the historians are 'discoverers' rather than 'inventors'. (Sometimes, indeed, they are represented as 'perverters' of genuine music, and it is implied that their productions should not really be thought of as musical at all.) The task of harmonics, then, is to identify the structures on which melodies *must* be based if they are truly to be melodies, the ways in which they can *properly* be related to one another, modified, recombined, and so on, and to uncover the unchanging principles which govern them and determine the immutable boundaries of the melodic realm.

When theorists have come to regard the subject in this light, we can say with some assurance that they are treating it as a full-blooded scientific discipline, a branch of investigation dedicated to the discovery and demonstration of a body of truths, regardless of whether they assimilate it to the mathematical sciences or to the 'sciences of nature', the realm of *physiologia*. Students of this branch of reality must therefore adopt as reliable a methodology, as rigorous an approach to the evidence and as meticulous standards of reasoning as those of any other. But the appearance of these views in the major fourth-century writings should not tempt us to run away with the idea that harmonics had any such pretensions from the start. In subsequent chapters I shall try to show that its original aspirations were much less ambitious, and that this fact has an important bearing on the way in which its pronouncements were treated by people outside the ranks of the theorists themselves. The relation between harmonics and other matters is not a constant. If harmonics is to be 'useful for reading' texts of any other sort or to help us in understanding the dynamics of Greek culture, it is imperative that each stage of its development should be located as exactly as possible in its own historical environment. In practice some of its phases

can be dated only very approximately, but we must do what we can. In this connection as in almost any other, generalisations which ignore chronology are almost bound to mislead.

When we come to these contextual matters, some of my conclusions will be familiar, at least in outline, to specialists in the adjacent fields in question. It will come as no surprise, for instance, to students of Plato or Aristotle or the Pythagoreans, that ideas drawn from harmonics had a significant role in their arguments and speculations; and the fact that it contributed to the theories in astronomy and medicine is almost equally well known. Precisely which form of harmonics and which of its aspects were involved is not always so clear, nor is it always easy to say whether the non-musical writers represent elements of harmonic theory accurately, or have misunderstood them or deliberately modified them for their own purposes. These issues need some attention if we are to understand what harmonics had to offer to natural scientists and philosophers; and we need to consider also the extent to which ideas flowed back into harmonics from these other directions. But at a general level, my comments in these areas will follow fairly well-trodden paths. Suggestions I make elsewhere may be more unexpected. It is often supposed, for example, that however intriguing harmonics may be as a body of abstract thought, and however important its contributions to philosophy and the sciences, it had little or nothing to do with the realities of Greek musical practice. Statements of this sort can be understood in two ways. They may mean either that the theorist's analyses had no basis in the facts and regularly misrepresented them, or that whether they did so or not, they had nothing to offer to musicians themselves or to connoisseurs in their audiences; they revealed nothing about individual compositions, and made no contribution to the skills of composition and musical appreciation. Except in certain very special cases, I shall argue, and perhaps even there, all these judgements are false. Another point at which my contentions may not match expectations is in the territory where ideas about music intersect with ethics, and where music is credited with a powerful influence on its hearers' emotions, dispositions and characters, a theme we meet repeatedly in philosophical writings and in more colourful terms in plays for the comic stage. Modern scholars have written copiously on this fascinating topic, especially in connection with Plato, and have often drawn on harmonic theory in the course of their interpretations.[6] I shall treat it a good deal more briskly and briefly than

[6] See for instance Moutsopoulos 1959, Lippman 1964 ch. 2, Anderson 1966, Gamberini 1996, Rossi 1988, 2000, Pagliara 2000, Boccadoro 2002.