Book Reviews

Works intended for notice in this column should be sent direct to the Book-Review Editor (R. F. Bryan, Department of Chemistry, University of Virginia, McCormick Road, Charlottesville, Virginia 22901, USA). As far as practicable, books will be reviewed in a country different from that of publication.

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On reflection. By JONATHAN MILLER. Pp. 224. New Haven: Yale University Press, 1998. Price US $40.00, £25.00. ISBN 1-85709-236-8.

How do we look at paintings? How do we decode the conventions of representation, and how do we negotiate the complex and contradictory illusions that painters have conjured? Taking the theme of reflection, this sumptuously illustrated book – and the recent exhibition at the National Gallery which accompanied it – explores how artists have exploited the opportunity that reflection offers 'for playing games with and on the spectator', and examines the possible rules of this kind of visual game. Jonathan Miller's own long experience with the ideas of cognitive psychology is brought to bear on this task, which develops in the second half of the book to consider ideas of child development and cultural aspects of mirrors as symbols of, for example, both vanity and prudence. The book concludes with a philosophical discussion of the possible relationship between perceptions and reflections.

Four physical operations are dealt with. Mirror symmetry is the peg on which Miller hangs many of his arguments. Though not specifically identified as such, the twofold rotation must needs be involved when we contrast the object we see in a mirror with what we see when we look directly at the object. Thirdly, the idea of scattering from a surface is essential in discussing the different quality of reflection seen from, for example, a matt surface compared to that in a silvered glass mirror. And, finally, the idea of coordinate transformations is used in discussing distortion of an image – most obviously, though not exclusively, in a curved mirror. Armed with these concepts, Miller presents and develops a number of ideas concerning perceptions and mechanisms of representation in paintings.

That we perceive the natural world itself in reflected light is set out sensibly right at the beginning. The quality of reflected light is presented as depending on the degree to which the object's surface is smooth or pitted. Coherence – a concept that I for one often have difficulty getting across to students – is used without definition to explain why smooth surfaces accurately reflect the image of the source. Why the rough nature of a matt surface scatters diffusely rather than reflecting 'coherently' is partially explained with the help of a simple diagram, though a sharp reader may see a flaw in this. Following this introduction, Miller moves into what for me is the most interesting part of the book – how an artist paints a reflection, and how he or she might use what is seen as a reflection as a representative device.

We move through the range of extremes from matt surface to mirror, through terms often applied, such as gleam, shine, flare, glimmer and lustre. From a relatively coarse surface, we see a relatively indistinct gleam or highlight whose colour is similar to the object, while, from a more 'lustrous' surface, the visibility of the lustre will depend on the observer's viewpoint, a point Miller credits Leonardo da Vinci with first realizing and using. As optical smoothness increases further, the resolution of the reflected 'highlight' can increase to the point where we can recognize the source of the light in miniature. And the degree of clarity of this reflected image can of course report back to us the quality of the surface texture. From a recognizable distortion in this reflected image, we can then begin to perceive something of the shape of the reflecting surface itself. A curved mirror will distort the image of a familiar object – as the curved mirror in the celebrated Van Eyck Arnolfini portrait distorts the reflection of the window of the room.

How much then of our interpretation of the contents of the picture depends on the context and on a comparison of what we see with what we expect to see? With respect to images that are distorted by curved mirrors, the answer is probably clear. As Miller illustrates using Robert Campin's Werl Altarpiece (p. 33), do a bit of computer graphics on the reflected window in a curved mirror to remove the curvature (p. 76, unfortunately not performed completely here) and remove other signals such as the frame, and the reflective gleam that you should have perceived originally in the mirror is now lost. The gleam, he argues, is not in the surface of the painting itself, it is induced in the observer's mind by the context.

When it comes to seeing reflections in plane mirrors, then the context is essential to recognize that we are seeing a reflection. As one illustration, he uses the peaches reflected in the surface of a tray in Desportes's *Silver Tureen with Peaches.* It's not just that we can no longer recognize that the peaches we see are reflections in the surface of the tray when all telltale signs of the tray are removed; this is hardly surprising as we know that a perfectly reflecting surface will deliver a perfectly laterally inverted image of the object. Unless what we see looks odd because of the lateral inversion (unlikely in most cases) then any physicist would expect not to be able to decide if he or she is looking at an object directly or in a mirror. Miller's point is that, in the context when we know it is a reflection, we are led to see a certain amount of reflected 'sheen' which vanishes when the clues that otherwise tell us we are looking at a reflection are removed.

Another example Miller gives of perceiving 'reflected sheen' in a reflection in a flat surface is the open window in Valloton's *Landscape in Provence* (Fig. 1). He argues again that, if we take away the context, we lose our perception of 'sheen' on the surface. In this view through an opened window onto houses and a landscape, the window is opened inwards so that part of the outdoor scene is reflected – with noticeable sheen – on the surface of the opened window. Isolate the window from the 'real' view, says Miller, and the evidence that it is a reflection is seriously reduced: it is, he asserts, difficult in the case of the isolated window to avoid the impression that we are looking through the glass to the view beyond. Here I part company with him. I still see a reflected image in the isolated window. Why do I see this differently from Miller? I suspect because the angle at which I perceive I am looking at the surface is sufficiently small that I would expect from the physics of reflection to see a reflected image rather than a transmitted one. I don't want to go in to the argument – often put as a negative aspect

of science by non-scientists – that understanding a phenomenon may reduce one's ability to appreciate the beauty of that phenomenon. Although I have never accepted this, it is clear that in this case my particular (scientific) background has made my perception of an object significantly different from that of Miller. Not that my perception is less valid than his. The difference between our perceptions perhaps demonstrates that what I see in a picture relates to my perception of the representation. My 'conceptual baggage' – which is here a certain degree of understanding of the physical processes involved – seems to have influenced my interpretation of the clues the artist has left behind. That my perception can be different from Miller's – or from anyone else's – is no reason to think that my alternative perception is not equally valid. This divergence of view between observers may, however, create a problem for the painter who uses a device to lead me into perceiving something in a certain way, when my own cognitive baggage – based on my own experience of the physical world – may lead me to perceive it differently from the way the painter may have intended.

Continuing this theme a little further, Miller takes pictures of reflections in flat surfaces such as water and encourages the reader to turn the page upside down and see how the perceived sheen of the original reflective surface vanishes. In some cases, yes, but not in all. As in the Vallotton window, in which my conceptual baggage prevents me from seeing the transmitted image that Miller perceives, there are often other supporting clues which make me prefer to conclude that I am seeing an upside-down picture rather than transposing the roles of the water and the sky. An artist friend tells me she may paint something specifically upside down as a device to prevent her putting too much of her – the artist's – conceptual baggage into a picture; the water surface quality as painted should carry with itself qualities of the water surface, and similarly the sky. You cannot reverse the two. I suspect therefore that Miller is underestimating the need for the painter to be able to reproduce technically in paint some quality of sheen or shine. An example that stands out to me is Magritte's famous *La Reproduction Interdite* (Fig. 2), which shows the back of a man standing in front of what the clues tell us is clearly a mirror. The trouble is the 'image' in the mirror is that of the man's back that we can see in front of the mirror, rather than the reflection of his front that we would expect to see. The man's image is apparently translated behind the surface of the mirror rather than reflected in it. Despite this, remove all surrounding clues that suggest this is a mirror and I still see reflected sheen! The artist has convinced me that I am looking into a mirror despite the conflicting contextual evidence of lack of lateral inversion. Surely he can have performed this only by a technical ability to convey in painting the presence of a reflected surface? Context is not all. Perhaps the technical ability of the artist is? The ability of magicians to deceive us seems a not dissimilar phenomenon. We know that spoon bending is a trick, but we can't see the mechanism.

It is halfway through the book before an explanation of 'the hoary old chestnut' of lateral inversion is attempted. The explanation given is confusing and inadequate – to me it sidelines the phenomenon as something so obvious that we needn't really worry about it. Statements such as 'in order to see the reflection of the front of something, it must be rotated about its vertical axis so that its recognizably different front now faces the reflective surface ...' are surely likely to confuse reflection with a twofold rotation. The explanation isn't helped by the fact that the figures used to illustrate lateral inversion on p. 91 contain an error which adds to the confusion. After reading this explanation several times, I still don't get an adequate explanation as to why I don't get inversion top-to-bottom. Again, the author seems to imply the reason is obvious and by implication I must be a fool not to see it as obvious as well. Though I can explain it myself, the book gives me no help, and confused others I showed it to.

Perhaps this is the point to mention a few other errors. That there *may* be 8 – not 7 – glasses in Stoskopff's *Still Life with Glasses and Pâté* on p. 35 may be genuinely difficult to decide and therefore not really significant. There are, however, real errors which are particularly worrying in that they confuse left with right. These not only do not help understanding, they confuse. They may be errors that were just not picked up in the proof-reading, but does the fact that they were there in the first place perhaps suggest some lack of certainty in the points being made? For example, the caption to the Dürer Erlangen drawing on p. 178 says the hand supporting his face is Dürer's right, while the text on p. 179 says his right hand is absent as it presumably executed the drawing. The caption is incorrect, the hand we see supporting the face is Dürer's actual left as seen in reflection. It would only be his right if this was a portrait executed by someone else. On the following page is another Dürer self-portrait, which shows his (in reality right) hand sizing himself up – not his actual left hand as the caption says. In the caption to the picture on p. 193 of Escher holding a reflecting globe, Miller comments that the hand holding the globe is the opposite to the one reflected in it, and so tries to suggest a further paradox. Really? Am I going crazy, or something? The reflection of the hand looks to me like a correct reflection. It would seem highly unlikely that Escher would have got this wrong (though perhaps it would not be untypical of Escher to try such a visual trick on us!). Someone – either Miller or me – is confused about what the reflection operation does. I verified my view experimentally with a real mirror and a real hand – mine. It is errors like these which make me sceptical that Miller is really on top of what is going on. Does he understand the difference between *m* and 2?

The involvement of mirrors in self-representation through self-portraits is discussed extensively, and again raises a number of problems which leave me at odds with Miller. For example, he asserts that the 'self-portrait' Dürer claims to have made when age 13 (p. 177) could not have been executed as a self-portrait. But the aspect presented is essentially the same as that in Janssen's *Self-Portrait at the Easel* (p. 190), so why should Janssen have been capable of doing something and Dürer not? The Dürer portrait has the little lad's eyes looking forward rather than being inclined towards us – isn't this something that could have been changed by the painter reasonably easily? Whether or not such a change is feasible for the artist, it is not necessary anyway. For as anyone can easily demonstrate by a little experiment, the use of two mirrors would turn the aspect he presents into a natural one for drawing himself, including the direction of his eyes.

Miller's discussion of self-portraits gives me the feeling that he accepts that a reflection shows the actual self. I would not assert, as Miller does, that, if it were not for reflections, I would not know what I looked like. It may have been true a hundred years ago (unless I were rich enough to get my portrait painted) but today I can see myself 'correctly' in a photograph or a video. What I see in a single reflection is not myself, but myself laterally inverted – and as I know that the imaginary

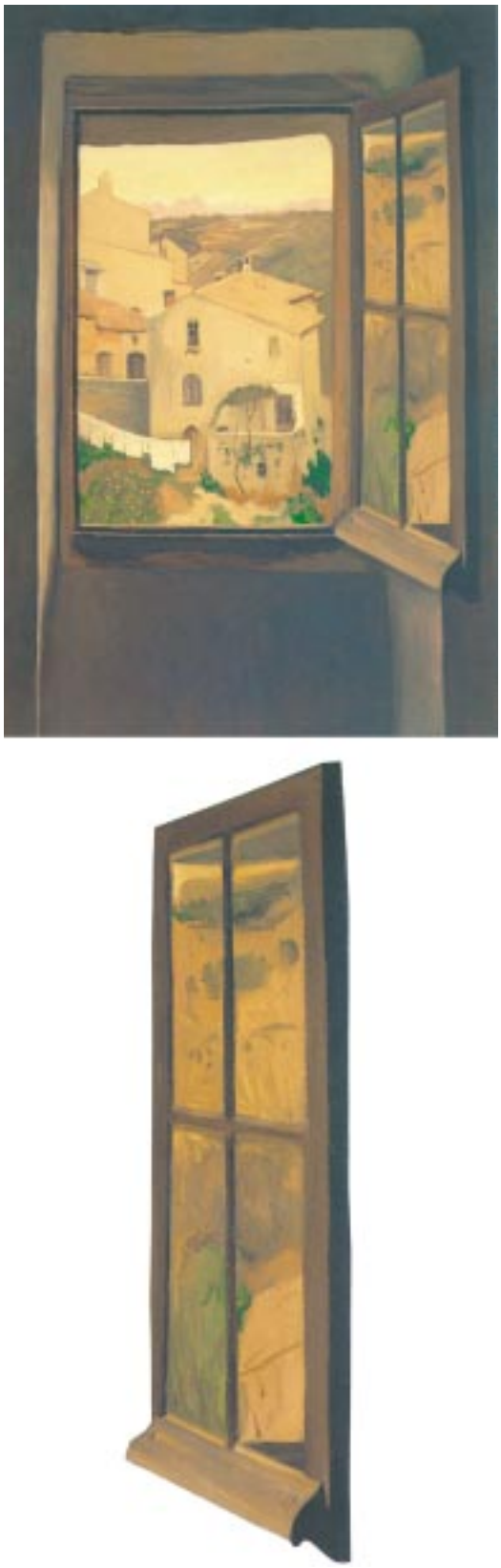

Fig. 1. The open window in Valloton's *Landscape in Provence.*

plane that bisects me from the top of my head to between my feet is not a perfect mirror plane (I have, like everyone else, significant left–right asymmetry), that is significantly different from how I look to everyone else. If I wanted to see what I looked like and had a really identical twin, I would look at the twin, not at myself in a reflection. And is it really true to say that, without mirrors, self-portraits would be inconceivable? Surely, *true* self-portraits are *not* possible in a single mirror – only laterally inverted ones. I don't think the majority of painters were left handed ....

One positive result of my reading this book is that it has turned me into a self-portrait 'junkie'. Contrary to Miller's statement (p. 200), we surely *can* distinguish between a self-portrait of an artist in the act of painting and one executed by another artist – the other artist would presumably get the painting kit in the correct hand. Miller again confuses me over the X-ray of the self-portrait of Rembrandt in Kenwood House, London. Assuming the work was executed in a single mirror (which the presented aspect makes likely), the painter is holding his brush and palette in his (actual) right hand. Miller comments that the X-ray reveals an earlier version with him holding them in the other – Miller states the *wrong* – hand. Which is the wrong hand and which is the right (correct) one in this case? Assuming Rembrandt was right handed, this would imply that he had tried, in the earlier attempt revealed in the X-ray, to transpose the brush and palette into what would appear to be the right (as opposed to left) hand if the painting had not been laterally inverted! Perhaps he was trying to correct for the lateral inversion so that the viewer would see him as he would in reality rather than as a laterally inverted reflection? And then thought better of it, and painted out the attempt?

Knowing if Rembrandt were left or right handed might throw some useful light on what he was trying to do in this self-portrait. What is the evidence from other Rembrandt self-portraits? From the evidence of the four I took at random (they happened to be the ones in a book I had to hand), the evidence is not conclusive, though suggestive of his being right handed. Assuming that all four of these were painted in single mirrors, the self-portrait drawing by a window (1648, Rijksmuseum) has the pencil in his *left* hand, while the Kenwood self-portrait has pallet and brush in his right hand. The self-portrait with his wife (1636, Rijksmuseum) also has his pencil in his *right* hand. In his self-portrait with a dead bittern (1639, Gemäldgalerie, Dresden), the bittern is in his left hand, with his *right* hand – which we might therefore presume did the painting – not visible. So what do we conclude from three to one in favour of being right handed? Perhaps he was ambi-dextrous? Perhaps he was able to transpose successfully the pencil in the self-portrait drawing of 1648 into the opposite hand to try to represent himself as *others* would see him? And a similar attempt to do the same thing in paint in the Kenwood picture was painted over as a failure? Or perhaps sometimes he used two mirrors? I think the jury is still out in resolving both this question and many of the other conclusions Miller tries to draw.

Of the twelve close-up self-portraits in the book which show the artist not facing fully forward, in ten of these we see the artist looking to our right. If you think about the process of painting a self-portrait in front of a mirror, then this would be the most natural way to do it if you are right handed. To paint the opposite aspect would be very uncomfortable, as your painting hand would be between you and the reflection,

making the move you would have to make to mark the canvas rather clumsy. Of the two where the opposite aspect is shown, one (Rockwell's *Triple Self-Portrait*, p. 189) is indeed in a rather uncomfortable position, while, in the second (Gentileschi *Self-Portrait as La Pittura*, p. 192), the artist is shown as painting with her left hand (assuming she was using a single mirror). So in addition to wanting to know if Rembrandt was right handed, and therefore had tackled (but then thought better of) the problem of reversing his self-portrait to make it *not* look not like a reflection, I would also like to know if Gentileschi really was left handed, as this self-portrait suggests. If not, she has succeeded admirably in painting a laterally inverted image of a laterally inverted image. This my portrait-painter friend tells me is unlikely to be achieved successfully – a painter paints his/her reflection, not their twofold rotated likeness (although as suggested above, perhaps Rembrandt was trying to correct the inversion). She could of course have used two mirrors, which would have transformed an aspect that would be – as Miller states – extremely difficult to paint, into one which was straightforward. In this case, she would appear to be right handed. But would she have had access to large plane mirrors in 1630? The detective work could go on and on ....

Moving away from portraits, how the use of reflections can make the observer aware of things outside the immediate view is discussed and illustrated. By the reflection device, we can see something of what the subject may be looking at, in effect overcoming the limitation of having eyes in the front of our heads. The use of the reflection device here is shown to lead to potential ambiguity; is what we see actually a reflection of what is behind us or not? Often we may need to dig around for quite subtle clues to decide one way or the other. And, to echo my earlier comments that people's perceptions of the evidence may differ, my interpretations of the clues are not always the same as Miller's. Could the fact that I do not know who is right suggest an ambiguity might be left intentionally by the artist in some cases?

This extension of the visible field through reflection is taken further to argue that painting rather than sculpture is more able to show multiple aspects of a subject. Because of its three-dimensionality, we can only observe the different facets of a sculpture by a sequence of observations as we walk round, or rotate, the object. Although a painting is on a flat surface, a painter can represent multiple aspects of a concept by showing multiple representations, each of which shows a different aspect of the concept. As Miller points out, Pollaiuolo's six executioners of San Sebastian might well be one and the same man, with each representation showing a different action or aspect, while the *Three Graces* could be thought a convenient device for conceptually rotating a three-dimensional figure on a two-dimensional representative surface. The use of reflection in one, or even more, mirrors allows the representation of several facets on the same flat surface simultaneously – though in discussing this in the case of a double mirror example (Savoldo's *Portrait of a Man*, p. 114) it would have helped if the detail of that picture presented here had not excluded one of the two mirrors that is essential if we are to understand the accompanying text! The actual version of the Savoldo depicting the two mirrors in fact appears later on p. 201 – another example of an unfortunate error not picked up during proof-reading.

Towards the latter part of the book, Miller discusses a range of cultural aspects of reflection – in particular human relationships to mirrors. Issues raised include the role of mirrors in child development and in developing the concept of self and a theory of mind. All of these discussions are interesting, but the role of reflection is surely only as an experimental tool rather than a – perhaps semi-magical? – conceptual device. He also illustrates how our relationship to mirrors can vary from the neutral to the moralizing. The moral relationship can itself range from the virtues of self-knowledge and prudence to the vices of pride and vanity; which is being represented in a particular case may not always be obvious from the context of the painting. Clues of vice and virtue may grade imperceptibly into each other; am I looking at myself because of vanity or because I wish to improve my self-knowledge?

And finally, what is our relationship to our own reflection? Using examples of 'disregarded reflections', in which a subject seems to be purposely looking away from his or her own reflection, the possibility that the reflection may be not oneself, but something that is destined to stay with one as some other self, is disturbingly raised. Echoes of the *doppelgänger*, and the possibility that the reflection has overtones of evil. Incidentally, is a *doppelgänger* a replica or a reflection? I had, without giving it too much thought, assumed it was a replica. If so, why build up reflection, as Miller does, as an important aspect of the whole concept of the existence of a double? No, the reflection is not alone in the development of this kind of idea. Dorian Gray had a portrait hidden in his room, not a frozen reflection. The point surely relates to the possible existence of another 'oneself', and reflection is just one – and not the only – way of deriving or representing it.

After an interesting discussion of 'phantom limbs' to show how reflections can exert a dramatic effect on our feelings, the last three pages turn into pretty heavy philosophizing that you can either reject as extreme, or look at as an interesting intellectual game. The mirror – with its ability to reflect an object to perfection – is, according to Miller, 'almost univer-

Fig. 2. Magritte's *La Reproduction Interdite.*

sally regarded as the epitome of representation'. Locke in the eighteenth century argued that human understanding can no more block out physical sensations than can a mirror refuse to reproduce the objects set before it. From this, Miller explores a possible philosophical parallel between a perception and a reflection, but is keen to not overlook their fundamental differences. Unlike a reflection, which I can compare with the object that is its source, I cannot compare a perception – for example of houses on the other side of the street – with its *un*perceived appearance. I have to take their representational character on trust. Reflections, then, Miller concludes, are not everything. But surely here he misses a trick, despite setting out the relevant elements at the beginning of the book? For what we see of the houses opposite is only a 'reflection' of part of the illumination that fell on the houses. So all our visual perceptions surely *are* only through (usually imperfect) reflections?

The book is enjoyable, interesting and stimulating. I have a nagging feeling – reinforced in discussions with others who have independently come to a similar conclusion – that Miller has tried to build up too much superstructure on the reflection concept (in some cases, his arguments hold equally for non-reflected images), but you can take what you want from what is offered. The surface texture of the pages is such as to show a little too much reflected gleam when read in a strong light, but perhaps that was designed in purposely to demonstrate a point? I came away with a strong message that what works in a picture depends as much on the viewer as on the artist, though I believe that Miller underestimates the technical skill that an artist puts into representing something as a reflection in favour of arguing that the context is more important. For a scientist who deals with the details of reflection, rotation and coordinate transformations all the time, some of the tricks which Miller argues are used to draw us to conclude something about an image may not be totally successful. But our perception is no less valid for that. The artist can't always get it right for everyone. Miller's view from his perspective is valid for himself, as is mine for me. And the perceptions of each of us are influenced by what we understand and know – or don't understand and don't know. How I look at a picture, how I decode the clues the artist has left, depend upon my own conceptual baggage, which is not necessarily the same as someone else's. There is danger in overgeneralizing to imply that we all look at things in the same way, and can be 'misled' by clues in the same way. That we can respond differently makes artistic perception all the richer.

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Physical properties of quasicrystals. Edited by E. M. STADNIK. Pp. xvi + 438. Berlin and New York: Springer Verlag GmbH, 1999. Price DM 198, US $134. ISBN 3-540-65188-8.

Quasicrystals were discovered in the 1980's. They are basically made of metals but exhibit a well ordered nonperiodic arrangement of atoms with long-range rotational symmetries. This unique structure has attracted considerable attention and its detailed determination has been the subject of many studies. The peculiarity of quasicrystals extends also to properties such as heat conduction, diffusion constants, phase transition, electron transport phenomena and mechanical behaviour. Since the beginning, quasicrystals have been objects of considerable cross disciplinary interest and a score of books (in English or French) has been published on different aspects of the subject, ranging from mathematical treatments to materials science.

The Editor's stated objective was to produce a comprehensive research-level monograph on the physical properties of quasicrystals. The book is 'intended for researchers in the field of the physics of quasicrystals, solid-state physicists, materials scientists, crystallographers, as well as for graduate students working in the area of new materials'.

The book is a collective work, involving about 20 scientists well recognized in the field of quasicrystals. The chapters have been written independently on various aspects of the material of interest. Using a panel of competent authors is certainly the best way to produce a monograph with the desired breadth and depth of coverage in all chapters. However, the possible drawbacks of this approach, in the absence of rigorous overall editing, are repetitions or, worse, contradictions and a lack of proper introductory material. These drawbacks have not been completely avoided here, as will be illustrated in our detailed analysis of the book.

After a short general introduction by the Editor, the book starts with Chapter 2 on the metallurgy of quasicrystals by An Pang Tsai, the man at the origin of the discovery and preparation of most of the stable quasicrystals. The chapter describes the several routes that may lead to quasicrystals, proposes classifications and introduces the field of phase transformation. The weak point may be the section devoted to phase diagrams where the most spectacular results published so far (notably on AlCuFe and AlPdMn) are not included.

Next come two chapters basically devoted to structure, by Walter Steurer & Torsten Haibach (Chapter 3) and Michel Boudard & Marc de Boissieu (Chapter 4). Chapter 3 is certainly one of the very good chapters in the book and crystallographers will find it interesting and well presented. Both chapters deliberately treat quasicrystals as perfect quasiperiodic structures with recovery of periodicity in a higher-dimensional space. This leaves out of the book consideration of three-dimensional approaches, such as varieties of random tiling and cluster models.

The lion's share of the book is devoted to electronic properties (Chapters 5–8, although Chapter 7 also includes other elementary excitations such as atomic vibrations). Two chapters focus on experimental results – mainly transport properties and spectroscopy – while the other two present models for electrons and phonons in quasicrystals. These four chapters overlap heavily and contain much repetition. Some contradictions may also confuse the average reader; for instance, Fujiwara in Chapter 6 emphasizes the importance of atomic clusters to explain narrow peaks in the density-of-states (DOS) and power-law dependence, while Hafner *et al.* in Chapter 7 repeatedly claim that eigenstates cannot be on clusters. This part of the book is, however, well documented and will be of