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Marx on the Dialectics of Elliptical Motion*

Thomas Weston
San Diego State University
tweston@mail.sdsu.edu

Abstract
It is a widespread view that Marx did not apply dialectics to nature, and that Engels's writings on this subject are a distortion of his outlook. This paper examines Marx's discussion of elliptical motion and some other physical phenomena, and shows that he did indeed find contradictions and oppositions in nature, and thus recognised a dialectics of nature. In addition to analysing relevant passages in Marx's texts, his study of the physics and mathematics of elliptical motion is reviewed and compared with Hegel's position.

Marx's conception of how dialectical contradictions are resolved is reviewed in order to interpret his claim that the contradiction in elliptical motion is 'solved' but not 'overcome' by that motion. Textual evidence is presented that Marx regarded 'real contradictions' as resolved only by 'development', a process in which the conflict between the opposing sides of the contradiction becomes more intense. The consequences of this interpretation for Marx's analysis of elliptical motion are explored, and some alternative interpretations are discussed.

Keywords
Marx, dialectics, contradiction, nature, development, resolution, Lukács

One of the contested issues in Marx interpretation is the relation of Marx's views on dialectics and natural science to those of Engels on these topics. Since the publication of Georg Lukács's *History and Class Consciousness* in 1923, a number of authors have affirmed Lukács's view that dialectical principles and methods do not apply to nature, and that the 'dialectics of nature' is a misinterpretation of Marx's thought initiated by Engels.[1] There have also been

* I wish to thank anonymous referees for helpful comments and criticisms.

1. 'The misunderstanding which arises from Engels's presentation of dialectics rests essentially on the fact that Engels – following Hegel's false example – extends the dialectical method also to the knowledge of nature.' (Lukács 1968, p. 63, n. 6; see Lukács 1971, p. 24, n. 6.) Lukács would later point out that his statements had concerned only '*the knowledge of nature* [*Naturerkenntnis*], not nature itself' (Lukács, 1996, p. 46). These and all other translations in this article are mine. An English version will be cited when available. Other well-known advocates of the view that Engels

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a number of responses to that claim; the best known was Avram Deborin's polemical article that appeared the year after Lukács's book.[2]

Deborin initiated a strategy followed by most of those who would contest the claim that a dialectics of nature was Engels's invention. This line of argument relies on the evidence of 40 years of collaboration between Marx and Engels, their extensive correspondence, and Marx's contributions to Engels's book *Herr Eugen Dühring's Revolution in Science*,[3] which applied dialectical ideas to nature.[4] Later writers have developed this line of argument much more fully.[5]

While this approach is legitimate, it is certainly preferable to let a philosopher speak for himself. We will see below that what Marx wrote about elliptical motion and some other topics shows that he did indeed find dialectical features in nature.[6] This paper examines Marx's statements about elliptical motion, and shows that he explicitly claimed that an elliptical path, such as that of a planet, is the result of a contradiction. Marx contended that an ellipse results from two tendencies of motion, whose contradiction is 'solved' but not 'overcome' by the planet's motion.[7] We will see that, for Marx, contradiction is the central concept of dialectics. Hence if there are contradictions in nature, then there is a dialectics of nature, a conclusion that follows from the contradictory nature of elliptical motion.

Marx distinguished contradictions [*Widersprüche*] of the kind studied in formal logic, which he called 'flat [*platten*]' contradictions or a 'contradictio in adjecto',[8] from 'Hegelian' contradictions, which we will call here 'dialectical' contradictions.[9] Marx also treated 'opposition [*Gegensatz*]', 'opposed [*entgegengesetzt*]', 'extremes [*Extremen*]', 'polar relation [*polares Verhältnis*]', and 'pole [*Pol*]' as categories closely related to contradiction.

Marx recognised that his dialectics would be an 'offence' and a 'horror' to bourgeois spokesmen.[10] The dialectics of contradiction, however, has also proved offensive to many of Marx's sympathetic interpreters. We will see

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distorts Marx on the dialectics of nature include Sartre 1976, pp. 27–9, and Carver 1983, Chapter 4. For a summary of the controversy, see Sheehan 1985, pp. 48–65.

2. Deborin 1924, pp. 49–69. A German translation of this essay appears in Cerutti, Claussen, Krahl, Negt and Schmidt 1971, pp. 90–112.

3. Engels 1968a.

4. Deborin 1924, pp. 62–3.

5. See Stanley and Zimmermann 1984, pp. 45–70; Rigby 2007.

6. Only statements by Marx or joint works of Marx and Engels will be cited as evidence of Marx's views in this paper.

7. Marx 1966, p. 118; Marx and Engels 1976r, p. 113.

8. Marx 1965a, p. 899.

9. See Marx 1966, p. 623, n. 848; Marx and Engels 1976r, p. 592, n. 2. Zeleny 1980, p. 223, describes five different senses of 'contradiction' in Marx's work.

10. Marx 1966, p. 28; Marx and Engels 1976r, p. 20.

that the key characteristic that distinguishes dialectical contradictions from related categories is the interference of the two sides of a contradiction, sides that should not be 'considered at rest next to each other', but are 'contending agents [*streitigen Agentien*]',[11] and are 'engaged... in their struggle [*Kampf*]',[12] a description that applies to the contradiction that Marx found in elliptical motion. We could then think of a flat contradiction as one in which the interference of opposing sides is absolute, so that the existence of either side makes the other impossible.

In the course of discussing Marx's treatment of elliptical motion, we will have to touch on other contentious issues of Marx interpretation, including the relation between dialectics as a theory of historical development and as a logic of conceptual relationships.[13] Examination of Marx's statements about elliptical motion will throw light on his views on how dialectical contradictions in society or nature cause change and find resolution.

Although little notice has previously been taken of the significance of Marx's discussion of elliptical motion for understanding his views on dialectics in nature, a number of authors have mentioned the ellipse passage's discussion of solving a contradiction without overcoming it in *Capital*, Volume 1.[14] We will examine and evaluate several of these interpretations of this passage.

The ellipse passage

Most of Marx's analysis of elliptical motion is contained in a single paragraph from Chapter III of *Capital*, Volume 1. Here is the passage:

> a) The Metamorphosis of Commodities
> We saw that the process of exchange of commodities includes relations that contradict and exclude one another. The development of the commodity does not overcome [*aufhebt*] these contradictions, but creates a form within which they can move themselves. This is in general the method through which real [*wirkliche*] contradictions solve [*lösen*] themselves. It is a contradiction, for example, for one body to continuously fall into another, and just as constantly fly away from it. The

11. Marx 1992, p. 323, slightly different from the published version, Marx 1965a, p. 259; Marx and Engels 1976s, p. 248.

12. Marx 1966, p. 792; Marx and Engels 1976r, p. 752.

13. For a summary of standard positions on dialectics as systematic or conceptual logic, see Steinvorth 1977, pp. 40–82, and Sagnol 1985. For dialectical logic in Marx's *Capital*, see Ilyenkov 1982, Vaziulin 2002, Smith 1990, Reichelt 2001 and Arthur 2008.

14. See Bartsch (ed.) 1986, p. 69; Iber 1990, p. 493, n. 26; Arndt 1994, pp. 305–6; Il'enkov and Mareev 1973, p. 68; Hu 2006a; Hu 2006b; Knapp and Spector 1991, p. 308; Rosental (ed.) 1975, p. 185; Stachel 2010.

> ellipse is one of the forms of movement in which this contradiction is actualised [*verwirklicht*] just as much as it is solved [*löst*].[15]

Marx here presents elliptical motion as a paradigm case that illustrates several points about contradictions, points which he asserts to be applicable to the circulation of commodities as well. To analyse this passage fully, we need to discuss Marx's views on the following issues:

1. Why Marx considered elliptical motion contradictory, and whether he was right to do so.
2. What physical analysis of elliptical motion Marx assumed, and its relation to Hegel's and Newton's treatments of this case.
3. The difference between overcoming [*aufheben*] a contradiction, which Marx denies here, and solving [*lösen*] one, which he asserts. This includes a discussion of how contradictions are resolved, in Marx's view.
4. The significance of a contradiction's being real or actual, and the mode of resolution that Marx expected for such contradictions.
5. Marx's aims in including the ellipse passage in *Capital*.

As a preliminary, we will need a brief review of the physics of elliptical motion, and particularly the analysis of the elliptical orbit of a planet, as this was understood in mechanics after Newton.

Elliptical motion in classical mechanics

In the classical mechanics pioneered by Newton, elliptical motion of a body will result if it is attracted to another 'central' body by a force inversely proportional to the square of the distance between them, provided that the body has an initial velocity that is not too large or too small, and not directly toward or directly away from the central body. This situation involves only a single force on the body, which, in the case of a planet orbiting the Sun, is the force of gravity. Gravity is not the only cause of this motion, however.

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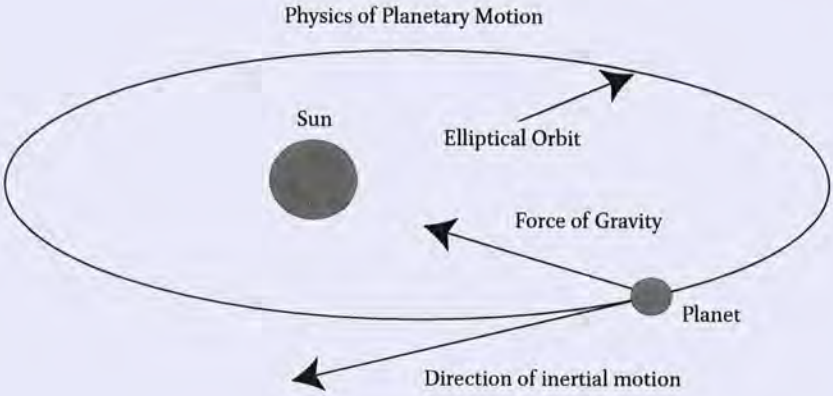
15. 'a) Die Metamorphose der Waren. Man sah, daß der Austauschprozeß der Waren widersprechende und einander ausschließende Beziehungen einschließt. Die Entwicklung der Ware hebt diese Widersprüche nicht auf, schafft aber die Form, worin sie sich bewegen können. Dies ist überhaupt die Methode, wodurch sich wirkliche Widersprüche lösen. Es ist z.B. ein Widerspruch, daß ein Körper beständigin einen andren fällt und ebenso beständig von ihm wegflieht. Die Ellipse ist eine der Bewegungsformen, worin dieser Widerspruch sich ebensosehr verwirklicht als löst.' (Marx 1966, pp. 118–19; Marx and Engels 1976r, p. 113.) Unfortunately the Aveling-Moore translation of this passage, which is reproduced in the English *Collected Works*, Marx and Engels 1976r, is seriously misleading. See the discussion below.



An elliptical orbit is the result of two causes, which produce two tendencies of motion. One tendency results from the force directed toward the central body, which makes the body turn toward that central body. The second tendency is that of the body to continue in a straight line at constant speed. This tendency is usually called 'inertia'. Inertia is not a force, since forces cause change in speed or direction, and inertia is the tendency *not* to change speed or direction. Inertia is a causal principle, as Newton recognised, calling it an 'innate force of matter'.[16] He expressed this principle in his first law of motion, while forces are described in the second law. In elliptical motion, these two causes, gravity and inertia, are united by the physical fact that the mass responsible for inertia is proportional to the mass that gives rise to gravity.[17] This fact is an important element in recognising the dialectical contradiction in elliptical motion.

Marx's knowledge of elliptical or planetary motion

During the last four decades of his life, Marx spent a great deal of effort studying various areas of natural science, including physics, astronomy, geology, physiology, chemistry, and mathematics.[18] The principal record of these studies is the voluminous collection of his notes and excerpts that is being

16. Newton 1964, p. 13.

17. Newton expressed this fact as the proportionality of weight to mass, established by experiment (Newton 1964, p. 13). Geometrical interpretations of modern relativity theory imply that inertial and gravitational mass are actually identical (Lawrie 2002, pp. 12–13).

18. For an overview and periodisation of Marx's natural-science studies, including the MEGA^2 volumes in which his studies of various sciences will appear, see Jäckel and Krüger 1989; Antonova 2004.

published in Section IV of the *Karl Marx, Friedrich Engels Gesamtausgabe* (MEGA²). The volumes that cover the years leading up to the publication of the first volume of *Capital* have not yet appeared.[19] Marx's comments in his works, his notes in books, and especially his letters to Engels give, however, quite a lot of information about his knowledge of the parts of physics and astronomy relevant to elliptical motion.

Two of Marx's important sources are Newton and Hegel. Marx's admiration for Newton was expressed several times. In an 1853 column in the *New York Tribune*, he referred to 'Newton's great discovery', presumably the law of universal gravitation.[20] In notes in his own copy of the Leibniz-Clarke correspondence, Marx commended some of Newton's points in the famous 'General Scholium' in Newton's *Principia* as 'Well said, old Isaak Newton', and 'Bravo, old Newton!'[21]

In their joint work *The German Ideology*, Marx's and Engels's estimate was that Newton had completed mechanics.[22] His letter to Engels in the summer of 1865 shows, however, that Marx had come to agree with Hegel that Newton's 'proof' of the law of gravitation had added nothing to Kepler's laws.[23] Marx had studied Hegel's views on planetary motion as early as his work on his doctorial dissertation in the early 1840s, making several outlines of Hegel's philosophy of nature.[24] The 1865 letter shows that Marx was studying Hegel's discussion of elliptical motion in his *Encyclopædia*[25] only a few years before publishing the first volume of *Capital*. We will see, however, that Marx came to adopt an analysis of elliptical motion that Hegel rejected.

Hegel's view of planetary motion

Given its possible influence on Marx, we must discuss a few aspects of Hegel's treatment of planetary motion and his critique of Newton. The interpretation and validity of Hegel's views on planetary motion have been the subject of an extensive controversy, but we will limit our discussion here to those aspects

19. Eleven of 31 volumes of notes and excerpts have appeared so far in the fourth section of MEGA². See <http://www.iisg.nl/imes/mega4.php> (accessed 19 July 2011). According to Jäckel and Krüger 1989, p. 298, Marx studied physics in 1866. Reiprich 1969, pp. 125–30, contains a chronological list of Marx's and Engels's notes and excerpts on natural science.

20. Marx 1976b, p. 93.

21. Kaiser and Werchan 1967, pp. 125–7.

22. Marx and Engels 1958a, p. 59; Marx and Engels 1976d, p. 72.

23. Marx to Engels, 19 August 1865, Marx and Engels 1976a, pp. 184–5.

24. 'Plan of Hegel's Philosophy of Nature', Marx and Engels 1976a, pp. 510–14.

25. See Hegel 1978c; Hegel 1970. Hegel also discussed his assessment of Newton and Kepler in Hegel 1978a, p. 408; Hegel 1969, pp. 343–4.

of Hegel's view that are essential for our purposes, which include some of his comments on Newton's *Principia*.[26]

Although Newton's treatment of planetary motion is broadly similar to the modern view, it differs from modern mechanics in his occasional use of the concept of 'centrifugal force [*vis centrifuga*]'. This concept first appeared in the 1713 second edition of the *Principia*, in the scholium to Proposition IV of Book I.[27] This 'force' was supposed to be directed outward, away from the Sun, in opposition to the force of gravity, which is called 'centripetal force'. Modern views reject the idea that 'centrifugal force' is a real force, rather than an unfortunate name for an effect of inertia, and Hegel did so as well.[28] But Hegel went much further. He not only rejected centrifugal force, but also claimed that all forces could be dispensed with [*entbehren*] in mechanics.[29] If we insist on speaking of forces in explaining the elliptical motion of a planet, he wrote, we must do so with one force – gravity – not two.[30]

Hegel was not merely objecting to the description of an inertial tendency as a force [*Kraft*], however. He claimed that inertia was legitimate only in 'finite mechanics', and was not part of the 'absolute mechanics' that applies to the motion of the planets.[31] Absolute mechanics concerns 'the great mechanics of the heavens',[32] which contain absolutely free motion. This free motion is elliptical, and Kepler's laws describe it.[33] Free motion cannot have external or contingent causes, but must be explained from the concept of matter. In this 'motion posited by the concept', which 'overcomes external accidental movement', inertia disappears.[34] Thus Hegel finds only a single cause of elliptical motion, in opposition to the Newtonian (and modern) two-cause view.

In the course of describing a 'gravity plus inertia' explanation of planetary motion that he rejected, Hegel gave a formulation that is strikingly similar to Marx's discussion of the ellipse: 'According to the law of its fall, a body is moved towards the centre of its gravity, and the bodies [i.e., the planets] have a drive [*Trieb*] toward the Sun; their tendency [*Richtung*] is a combination of this drive

26. The areas of controversy and the views of the main participants are reviewed briefly in Ihmig 1989, pp. 13–14. For more recent contributions, see Petry (ed.) 1993; Février 2000; Posch 2005; Halper 2008.

27. Newton 1713, p. 40; Newton 1964, p. 49.

28. For Newton's views on centrifugal forces, see Brackenridge and Nauenberg 2002.

29. §265 *Zusatz*, Hegel 1978c, p. 68; Hegel 1970, p. 51.

30. §269 *Zusatz*, Hegel 1978c, p. 85; Hegel 1970, p. 65.

31. §264, Hegel 1978c, p. 65; Hegel 1970, p. 48.

32. §269 *Zusatz*, Hegel 1978c, p. 84; Hegel 1970, p. 64.

33. §270, Hegel 1978c, pp. 86–7; Hegel 1970, p. 66.

34. §266, Hegel 1978c, p. 73; Hegel 1970, p. 55.

and the tangential tendency, and the resulting tendency is the diagonal.'[35] This passage has key elements in common with Marx's formulation. The tendency that he identifies, that 'one body should continuously fall into another', corresponds to Hegel's statement that 'bodies have a drive toward the Sun'. Marx's other tendency, for one body to 'just as constantly fly away from' the other, corresponds to Hegel's 'tangential tendency', which leads away from the Sun. The resulting elliptical path lies along a direction that approximates what Hegel called a 'diagonal' between the gravitational and inertial tendencies. Hegel rejected this formulation because he regarded the tangentially directed inertial tendency as a mere 'empirical coefficient', rather than a force or a law,[36] although for Newton it was a law, the first law of motion.

Hegel's passage does not say that the force of gravity and inertia are contradictory, as Marx does, but Hegel did claim that gravity 'directly contradicts [*unmittelbar widerspricht*] the law of inertia'.[37] Although his reasoning is obscure, Hegel also claimed that elliptical motion itself involves a contradiction, but not the same as the contradiction that Marx identifies between two tendencies of motion,[38] gravity and inertia, which was rejected by Hegel.

Marx's study of astronomy and physics

In addition to his early study of Hegel's physics and his re-reading of it in the 1860s, Marx's studies included a number of other sources on astronomy, physics and mathematics relevant to elliptical motion.

In 1864 Marx described to several correspondents his study of Grove's *Correlation of Physical Forces*. In August 1865, Marx wrote to Engels that he had taken the opportunity 'to "take up" a little astronomy' again, including the study of Laplace's nebular hypothesis and the work of 'a Yankee, Kirkwood'. Kirkwood proposed a law relating a planet's rate of rotation to the width of the gaseous ring from which the planet had formed.[39] Engels was not familiar with

35. §270 *Zusatz*, Hegel 1978c, p. 97; Hegel 1970, p. 75.
36. §270, Hegel 1978c, p. 97; Hegel 1970, p. 75.
37. §269, Hegel 1978c, p. 83; Hegel 1970, p. 63.
38. Roughly speaking, the contradiction that Hegel found in elliptical motion is between the independent (for-itself) existence of the centre, and the unification that the centre gives to all the bodies that fall toward it. §268, Hegel 1978c, p. 80; Hegel 1970, pp. 60–1.
39. Marx to Engels, 19 August 1865, Marx and Engels 1976u, p. 184.

Kirkwood's proposal,[40] which Marx thought might explain the difference in the rotation rates of Jupiter and Venus.[41]

Marx's study of algebra and calculus

Marx's extensive mathematical manuscripts, written in the 1880s, are well known,[42] but his letters, manuscripts, and his personal library are evidence of his earlier mathematical studies, in the 1840s, '50s, and '60s. Works on conic sections and differential calculus in Marx's library, published in the 1840s, show calculations, notes and marginal comments by Marx.[43] In May 1865, Marx wrote to Engels that he was studying differential calculus.[44] In a letter to Engels in late 1865 or early 1866, Marx responded to Engels's request for information on differential calculus by explaining how to calculate the tangent to a given curve. He wrote that the calculus had originally arisen from the problem of drawing tangents to curves, including ellipses.[45]

The conclusion that follows from these details is that Marx's study of physics, astronomy, and mathematics in the years leading up to the 1867 publication of Volume 1 of *Capital* was sufficient for him to be confident that he could make use of it for illustrations of dialectical principles, as he did in the ellipse passage. Marx also did this with his knowledge of chemistry, maintaining that natural science had proved the correctness of Hegel's law 'that merely quantitative changes up to a certain point turn into qualitative differences', and that the molecular chemistry developed by Laurent and Gerhardt illustrated this.[46] According to Engels, this law is part of dialectics.[47]

Hegel on contradiction

To continue our investigation of the ellipse passage, we need to determine what Marx meant by its dialectical terminology, including 'contradiction', 'real

40. Engels to Marx, 21 August 1865, Marx and Engels 1976u, p. 186.
41. Marx to Engels, 22 August 1865, Marx and Engels 1976u, p. 187.
42. Institut Marksizma-Leninizma 1968.
43. Kaiser and Werchan 1967, pp. 85–7, 94, 100.
44. Marx to Engels, 20 May 1865, Marx and Engels 1976u, p. 159.
45. Marx to Engels, late 1865 or early 1866, Marx and Engels 1976u, pp. 208–10.
46. Marx 1966, pp. 327, 327, n. 390; Marx and Engels 1976r, pp. 313, 313, n. 2. On Marx's study of chemistry, see Marx to Engels, 22 June 1867, Marx and Engels 1976u, p. 385; Marx to Engels, 7 December 1867, Marx and Engels 1976u, p. 495; Antonova 2004, pp. 60–77. Marx's excerpts on chemistry from 1877–83 appear in Marx and Engels 1999a.
47. Engels 1968b, p. 348; Marx and Engels 1976m, p. 356.

contradiction', 'solve [*lösen*]', 'overcome [*aufheben*]', and a few others. Since Marx's terminology is borrowed from Hegel, we need to make a brief review of Hegel's dialectical theory.[48]

In the famous second chapter of the Doctrine of Essence in his *Science of Logic*, Hegel put special emphasis on a series of four essential relations: *identity* [*Identität*], *difference* [*Unterschied*], *opposition* [*Gegensatz*], and *contradiction* [*Widerspruch*]. Each of the last three is supposed to result from the dialectical development of the preceding one. Opposition is a relation in which the two sides determine each other, but also determine themselves and exclude each other.[49] Hegel distinguished contradiction from opposition by the category of *negativity*, which means, roughly, *conflict* of the opposite sides: 'Opposites [*Entgegengesetzten*] contain contradiction in so far as they relate to each other negatively in the same respect or are both *mutually cancelling* [*aufhebende*] and *indifferent* to each other.'[50] It is the negativity of a contradiction that is responsible for its key role in dialectical theory, that contradiction causes motion: 'The sides of a manifold only become active and lively against each other when they are driven to the peak of contradiction, and contradiction contains the negativity, which is the indwelling pulse of self-movement and liveliness.'[51] Hegel claimed that 'something is ... active only in so far as it contains contradiction',[52] but contradictions also move toward their own *resolution* [*Auflösung*], that is, to ceasing to be contradictions. In Hegel's view, resolution of a contradiction involves *overcoming* [*Aufhebung*] it. Overcoming preserves the two sides of a contradiction, although in an altered form. 'Something is overcome only insofar as it has entered into unity with its opposite',[53] and such a unity results from resolution: 'A resolved contradiction is thus a ground, an essence as the unity of positive and negative. ... In a ground, an opposition and its contradiction are therefore just as much overcome as maintained.'[54]

Marx's dialectical terminology

The relation of Marx's views about dialectics to Hegel's ideas has been a hotly contested topic in Marx scholarship,[55] but we can establish the basic fact that

48. Marx discusses the relation of his dialectics to Hegel's in *Capital*, Marx 1966, p. 27; Marx and Engels 1976r, pp. 19–20.
49. Hegel 1978b, p. 64; Hegel 1969, p. 431.
50. Hegel 1978b, p. 77; Hegel 1969, p. 441.
51. Hegel 1978b, p. 78, Hegel 1969, p. 442.
52. Hegel 1978b, p. 76; Hegel 1969, p. 440.
53. Hegel 1978a, p. 114; Hegel 1969, p. 107.
54. Hegel 1978b, p. 69; Hegel 1969, p. 435.
55. See Williams et al. 2000a and 2000b for a recent discussion.

we need here, that Marx uses Hegel's dialectical terminology in senses close to Hegel's. In the *Grundrisse*, Marx's treatment of difference, opposition, and contradiction affirmed Hegel's developmental sequence, maintaining that the dual character of the commodity must progress from difference to opposition to contradiction.[56] In several works Marx describes development from opposition to contradiction, and hence to resolution. For example, in the *1844 Manuscripts*, Marx wrote: '... the opposition of propertylessness and property is still an indifferent relation, not yet *active*, and its *inner* relation is an opposition that is not yet grasped as contradiction.... But labour, the subjective essence of private property as the exclusion of private property, and capital, objective labour as the exclusion of labour, is *private property* as its developed relation of contradiction, hence *an energetic relation driving toward resolution*.'[57] For Marx as for Hegel, the main difference between opposition and contradiction is negativity, the internal activity of a contradiction. Two contradictory sides are 'contending agencies'[58] that are 'engaged... in their struggle [*Kampf*]'.[59]

Marx referred to oppositions that are not contradictory as *supplementary* [*ergänzender*], describing, for example, a form of exchange in which 'there is a possibility of essentially supplementary moments tearing and falling apart'.[60] Being supplementary is a not the permanent condition of an opposition, but merely expresses dominance of the unifying aspect, a dominance that can disappear as the opposition comes apart: 'Processes that are inwardly dependent and hence mutually supplementary progress to externally independent processes up to a certain point and thus make themselves forcefully unified through a crisis.'[61] Thus oppositions can lose their supplementary character and be 'increased to an absolute contradiction'.[62]

Polar opposites

Hegel defined polarity as 'the characteristic of a difference in which the different sides are *inseparably* bound'.[63] Marx glosses poles as having a much

56. Marx 1983a, pp. 81–2; Marx and Engels 1976n, pp. 84–5.
57. Marx 1990, p. 533, emphasis added; Marx and Engels 1976b, pp. 293–4.
58. Marx 1992, p. 323.
59. Marx 1966, p. 792; Marx and Engels 1976r, p. 752. Negativity is an abstraction of *conflict*, not of the *absence* of something. Both Marx and Hegel generally understand it in this way. In the *1844 Manuscripts*, Marx praised Hegel's 'dialectic of negativity'. Marx 1990, p. 574; Marx and Engels 1976b, p. 332.
60. Marx 1965c, p. 509; Marx and Engels 1976q, p. 139.
61. Marx 1966, pp. 127–8; Marx and Engels 1976r, p. 123.
62. Marx 1966, p. 152; Marx and Engels 1976r, p. 149.
63. Hegel 1978a, p. 21; Hegel 1969, p. 32.

stronger relation: 'mutually conditioning, inseparable moments that belong to each other', which are 'at the same time mutually excluding, opposing extremes'.[64] This sounds just like a definition of opposition. Marx's use of polar terminology in the period when he wrote and revised *Capital* shows that the relation between opposing poles is not always supplementary. For example, in the 1871 *Civil War in France*, Marx described the 'two poles' of the present society as 'capital and wage-slavery',[65] which he certainly did not regard as supplementary. Likewise in *Capital*, Volume 1, Marx wrote that in expanded reproduction there are '... more or bigger capitalists at this pole, and more wageworkers at the other'. In the circulation of commodities, 'commodities exist at one pole, and money at the opposite pole'. In a crisis, however, 'the opposition between the commodity and money, its value-form, increases to an absolute contradiction'.[66]

Contradiction and opposition

Marx often used opposition and contradiction in combination as 'oppositions and contradictions'.[67] Although Marx recognised a distinction between contradiction and opposition, he was not always consistent about this, and sometimes used 'opposition' to express a relationship that plays the role of a contradiction. In an 1848 article, for example, Marx described oppositions in these terms: 'England [is] ... the country in which the oppositions of modern bourgeois society, the class struggles between bourgeoisie and proletariat, are developed most fully and driven to the highest peak... England has no need of a stumbling continental provisional government in order to come nearer to the solution [*Lösung*] of the question, to the overcoming [*Aufhebung*] of oppositions, which is *its* vocation [*Beruf*] more than all other countries.'[68] The terminology of being driven to a peak and overcoming in this passage appears to describe the process of the resolution of a contradiction, although the term Marx actually uses here is 'oppositions [*Gegensätzen*]'.

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64. Marx 1966, p. 63; Marx and Engels 1976r, p. 58.

65. Marx 1964c, p. 342; Marx and Engels 1976j, p. 335.

66. Marx 1966, pp. 641, 149, 152; Marx and Engels 1976r, pp. 609, 145, 149. The claim in Stachel 2010 and Göhler 1980, p. 67, that for Marx polar opposites are not *logical* contradictions is certainly true, but beside the point. The cited passages show polar opposites can be or can become dialectical contradictions. My view is that there is no difference in Marx's usage between opposition and polar opposition, except that Marx may have regarded the polar terminology as more accessible.

67. See Marx 1966, p. 587; Marx and Engels 1976r, p. 562; Marx 1983a, p. 81; Marx and Engels 1976n, p. 85; Marx 1965c, p. 500; Marx and Engels 1976q, p. 131.

68. Marx 1961a, p. 77; Marx and Engels 1976f, pp. 101–2.

It actually makes sense that Marx should not always distinguish between contradiction and opposition, since he recognised Hegel's developmental sequence according to which opposition must develop into contradiction. His revisions of *Capital*, Volume 1, for the second edition suggest, however, that he was then taking greater care in distinguishing opposition from contradiction.[69]

Sides of a contradiction

Marx described various kinds of entities as entering into contradictory relationships. These include tendencies [*Tendenzen*],[70] phenomena [*Erscheinungen*], conflicting agencies [*streitigen Agentien*], influences [*verscheidenen Einflüsse*],[71] and requirements [*Forderungen*][72] to which a process may be subject. Contradictory tendencies can be present at the same time,[73] but this is not required. 'Contradictory determinations [*widersprechenden Bestimmungen*]', such as the increase in the length of the working day and the decrease in the labour time necessary for production, can also 'alternate in time [*sich in der Zeit ablösen*]'.[74] Marx rarely asserted that a characteristic is both present and not present at the same time, and when he did so, he seems be referring to different aspects of the characteristic.[75]

69. 'Widerspruch' and its variants occur two dozen times in the first four chapters (and the Appendix to Chapter 1) of the first edition, the area of the text that has the highest concentration of dialectical terminology. For that edition, Marx deleted two occurrences of 'contradiction' (Marx 1983a, p. 51), and twice replaced 'contradiction' with 'opposition' (Marx 1983a, p. 54; Marx 1966, p. 102). The substantive change here was to drop the assertion that use-value and exchange-value are in 'immediate [*unmittelbarer*] contradiction'. The assertion that the 'opposition of use-value and exchange-value' is an 'immanent contradiction' appears in both editions, however (Marx 1983a, p. 74; Marx 1966, p. 128; Marx and Engels 1976r, pp. 123–4). The remaining 20 occurrences of 'contradiction' and its variants were not changed, including four occurrences in the ellipse passage. Marx also deleted half a dozen occurences of 'polar' and its variants.

70. Marx 1965a, p. 259; Marx and Engels 1976s, p. 247; Marx 1983a, p. 259; Marx and Engels 1976n, p. 350.

71. Marx 1992, p. 323, cf. Marx 1965a, p. 259; Marx and Engels 1976s, p. 248.

72. Marx 1983a, p. 662; Marx and Engels 1976o, p. 153.

73. Marx 1992, p. 323, cf. Marx 1965a, p. 259, Marx and Engels 1976s, p. 248.

74. Marx 1983a, pp. 661–2; Marx and Engels 1976o, p. 153.

75. See Marx 1966, p. 209; Marx and Engels 1976r, p. 205. Marx asserted there that the transformation of money into capital takes place in the sphere of circulation and also does not take place there. In Marx 1983a, p. 314; Marx and Engels 1976n, p. 327, Marx asserted that capital both posits and does not posit necessary labour.

Real contradictions

Although Marx recognised contradictions within theories and concepts,[76] contradictions between theories, between what is apparent and what is real,[77] between theory and practice,[78] and between theories and reality, he also maintained that there are contradictions in reality itself.

A recurring theme in Marx's works from the early 1840s and throughout his work on *Capital* is that contradictions and oppositions are contained in reality, not just in people's thinking about it. He claimed that there are 'real contradictions [*wirklichen Widersprüche*]' in bourgeois production,[79] and that the 'existing contradictions [*existierenden Widersprüche*]' in bourgeois production cause crises.[80] There are 'real contradictions [*realen Widersprüche*]'[81] between the wealth of the nation and the poverty of the workers and 'real oppositions [*realen Gegensätze*]'[82] in the economic life of society. Capital itself has an 'oppositional character [*gegensätzliche Charakter*]', and Marx criticises economists who want to 'talk away [*wegschwatzen*]' difficulties lying in the 'contradictory determinations of things themselves [*widersprechenden Bestimmungen der Dinge selbst*]' by regarding these characteristics as the product of thought or the conflict of definitions.[83] It 'goes without saying', Marx wrote, that 'paradoxes of reality [*Wirklichkeit*]' are expressed in 'linguistic paradoxes [*Sprachparadoxen*]', but 'these contradictions lie in the thing [*liegen in der Sache*], not the linguistic expression of the thing'.[84]

Unfortunately Marx does not always apply the term 'real [*real, reell, wirklich*]' to contradictions only to mark the distinction between contradiction in thought or theory versus contradiction in the social or natural world. He also uses these terms, especially 'real [*wirklich*]', to distinguish what is real from what is merely apparent, imaginary, illusory, etc. For example, Marx criticises James Mill both for trying to prove that the actual contradictions of bourgeois production are only apparent [*scheinbar*], and also for attempting to solve the real [*reell*] contradictions in a theory by mere phrases.[85] In our ellipse passage, the real contradiction in elliptical motion is a contradiction of tendencies of motion that is 'actualised [*verwirklicht*]', hence is not merely mental or

76. Marx 1965a, p. 849; Marx and Engels 1976s, p. 828.
77. Marx 1965c, p. 163; Marx and Engels 1976p, p. 391.
78. Marx 1974a, p. 367; Marx and Engels 1976b, pp. 164–5.
79. Marx 1965d, p. 80; Marx and Engels 1976q, p. 275.
80. Marx 1965d, p. 117; Marx and Engels 1976q, p. 308.
81. Marx 1965d, p. 256; Marx and Engels 1976q, p. 394.
82. Marx 1965d, p. 492; Marx and Engels 1976q, p. 501.
83. Marx 1965d, pp. 485, 129; Marx and Engels 1976q, pp. 495, 319.
84. Marx 1965d, p. 134; Marx and Engels 1976q, p. 324.
85. Marx 1965d, pp. 80, 84; Marx and Engels 1976q, pp. 275, 278.

conceptual. It is also real [*wirklich*], however, so is not merely apparent. Marx's use of the term 'real' leaves open the possibility that the general claim of that passage, that 'real contradictions' are only solved by finding a way to move, might have been intended to apply to real mental or theoretical contradictions as well as physical or economic ones.

Why the two sides contradict each other in elliptical motion

I have characterised the two sides of the ellipse contradiction as 'tendencies' of motion, although Marx does not use that term in the ellipse passage. He described various features of capitalism as involving contradictory tendencies, in particular the tendency of the rate of profit to fall and its counteracting tendencies. In his discussion of the process of centralisation of capital in *Capital*, Volume 3, however, he uses a metaphor which shows that contradictory tendencies are involved in elliptical motion. He wrote that: 'This process [of the concentration of capital in the hands of a few large capitalists] would soon bring the capitalist system to an end if counteracting [*widerstrebend*] tendencies did not also continuously work beside the centripetal force.'[86] Here 'centripetal force' causes the centralising tendency and has other tendencies that act against it.

In the ellipse case, the two tendencies are opposites because they are mutually exclusive and unified by a common source, the mass of the planet (and the Sun), from which both inertia and gravitational force result.

As we saw above, an opposition is a contradiction if negativity is present, that is, if the two sides interfere with each other. From Marx's brief comments, he appears to have thought that it is obvious that falling into a body and flying away from it are contradictory tendencies, but we can reinforce his conclusion. Although tendencies can interfere with each other in numerous ways, I suggest that the following criterion is a *sufficient* condition for negativity of, or interference between, opposing tendencies A and B:

> Tendency A, if strong enough, will cause the opposite tendency B to be less fully realised than if tendency A were absent, and conversely.[87]

This criterion is satisfied by both tendencies that Marx finds in the ellipse case. The tendency of a planet to fly away from the Sun will only result in its actually flying away (a parabolic or hyperbolic orbit) if the tangential velocity

86. Marx 1992, p. 315. Cf. Marx 1965a, p. 259; Marx and Engels 1976s, p. 248.
87. This criterion is similar to a proposal in Crocker 1980.

is large enough to overcome the counter-tendency produced by gravity. On the other side, the tendency of the planet to fall into the Sun will only result in the planet actually hitting the Sun if the tangential tendency is small compared with the gravitational tendency. Thus unless one of the tendencies is too weak to constrain the other, each tendency prevents the realisation of the other. At least one will not be fully realised, although both may be partially realised.[88]

Contradictions and movement

Like Hegel, who saw contradiction as 'the root of all movement',[89] movement is central to Marx's treatment of real contradictions. As the ellipse passage says, the solution of real contradictions creates movement.[90] Contradictions produce movement because they 'drive toward resolution',[91] converting their internal activity into external change. Movement can take a variety of forms: 'contradictory oscillations',[92] movement along a definite path like an ellipse, or the movement of capital, brought about by conflicts between its devaluation [*Entwertung*] in the production process, and the production of conditions for its valorisation [*Verwertung*].[93] Contradictions of capitalism lead to 'explosions, cataclysms, crises, ... regularly occurring catastrophes ... [and] finally to its violent overthrow'.[94] In *The Poverty of Philosophy* and the *1844 Manuscripts*, Marx also describes Hegel's views on the dialectics of categories and thoughts as 'dialectical movement [*movement dialectique*]'[95] and 'the movement of abstract thought', so movement can sometimes be a conceptual process.[96]

Our interest here is in movement as a necessary means for the solution [*Lösung*] or resolution [*Auflösung*] of contradictions. In particular we need to develop the means to interpret Marx's claim that elliptical motion solves but

88. See the Appendix for the physics details. Stachel 2010 argues that there is no contradiction in elliptical motion and conjectures that Marx misunderstood Newton. He does not, however, try to analyse elliptical motion as the result of two tendencies, as Marx does. Even if Marx's analysis of elliptical motion were scientifically incorrect, however, the ellipse passage would still show that he *believed* there are contradictions in nature and thus accepted a dialectics of nature.

89. Hegel 1978b, p. 75; Hegel 1969, p. 439.

90. Marx 1966, pp. 118–19; Marx and Engels 1976r, p. 113.

91. Marx 1990, p. 533; Marx and Engels 1976b, p. 294; Marx 1983a, pp. 160, 445; Marx and Engels 1976n, pp. 166, 463.

92. Marx 1965d, p. 454; Marx and Engels 1976q, p. 459.

93. Marx 1983a, p. 360; Marx and Engels 1976n, p. 376.

94. Marx 1983a, p. 643; Marx and Engels 1976o, p. 134.

95. Marx 1990, p. 574; Marx and Engels 1976b, p. 332.

96. Marx 1972, p. 122; Marx and Engels 1976e, p. 168.

does not overcome a contradiction. Thus we must investigate Marx's views on how contradictions are resolved.

Marx on the resolution of contradictions

Although Hegel and Marx agree fairly closely on the basic features of oppositions and contradictions, they have quite different views on the process and the result of the resolution [*Auflösung, Lösung*, or *Aufhebung*] of real contradictions and oppositions.

According to Hegel's treatment in the *Science of Logic*, contradictions are resolved by incorporating them into a more inclusive whole, a 'higher sphere'[97] in which the contradiction is 'overcome [*aufgehoben*]'. A contradiction is 'overcome' if its two sides are altered by incorporation into a higher sphere, but are also preserved in this altered form so that they no longer contradict each other.[98] This overcoming is the result of *mediation*, providing a link between the opposite sides, which then form a more inclusive totality. Something 'is overcome, only insofar as it enters into a unity with its opposite'.[99] The result of this mediating process is a situation in which a 'contradiction has not abstractly vanished, but is resolved and reconciled'.[100] The question of how and to what extent these passages from Hegel's *Logic* apply to real processes in the world is in general a difficult one.[101] In his *Philosophy of Right*, however, Hegel explicitly claimed that mediation could produce the result that 'opposition itself is reduced to a mere appearance [*der Gegensatz selbst zu einem Schein herabgesetzt*]', preventing the destruction [*Untergang*] of the state.[102]

In his early critique of Hegel's *Philosophy of Right*, Marx not only denied the possibility of mediation of specific social oppositions and contradictions, such as those between the monarch and civil society, but also presented a general critique of mediation, which claimed that 'Real [*wirklich*] extremes cannot be mediated precisely because they are real extremes.'[103] Opposites are *real*

97. Hegel 1978b, p. 79; Hegel 1969, p. 443.

98. Hegel 1978b, p. 69; Hegel 1969, p. 435.

99. Hegel 1978a, p. 114; Hegel 1969, p. 107.

100. Hegel 1978a, p. 168; Hegel 1969, p. 152.

101. This is the question of the relation between Hegel's logic and social, mental, or natural reality. For a general discussion of this issue, see Nuzzo 1997.

102. Hegel 1979, p. 472; Hegel 2002, p. 238.

103. Marx 1974b, p. 292; Marx and Engels 1976b, p. 88. On Marx's conception of mediation in this work, see Rosental (ed.) 1975, pp. 29–36; Berki 1971, pp. 199–219.

opposites, however, only if they are 'opposed in essence [*sind entgegengesetzten Wesens*]', and 'do not supplement each other [*ergänzen einander nicht*]'.[104]

In particular, the opposition between civil society and monarch is a 'battle-opposition [*kampfgerechten Gegensatz*]' and an '*irreconcilable* [*unversöhnlichen*] *contradiction*'.[105] Hegel's chief error, according to Marx, had been to conceive of contradiction as a contradiction of *appearances*, but also a 'unity in essence, in the Idea', when the contradiction is actually a contradiction in essence.[106] Hegel was also wrong to regard the intensification of the struggle of opposites, their 'inflammation [*Entzündung*] to a decision', that is, to the defeat or destruction of one side, as 'something possibly to be prevented or something harmful', which required mediation.[107]

Some authors have denied that Marx carried over this early attack on resolution of real oppositions by mediation into his later work. When his Hegel critique was first published in 1927, its first reviewer, N.M. Karev, at that time a prominent Soviet philosopher, dismissed it as an early 'Feuerbachian' view, which was later superseded.[108]

The evidence from Marx's later work does not support this claim, although it does show some changes in terminology. In particular, the best equivalent in Marx's later terminology to his early expression 'real extremes' that are 'opposed in essence' would probably be the term 'real contradiction'. In *Capital*, Volume 1, Marx does give examples of extremes that are mediated; for example, money thrown onto the market and money withdrawn from it are mediated by purchase and sale.[109] He several times characterises the oppositions occurring in circulation as 'supplementary', thus not 'opposed in essence', as the earlier term 'real extremes' required. Marx does say, however, that these oppositions can *become* contradictory.[110]

In the *Grundrisse*, Marx wrote that wealth mediates between the extremes of use-value and exchange-value, and that merchant capital mediates between industrial capital and the consuming public.[111] Marx certainly did not mean by

104. Marx 1974b, p. 292; Marx and Engels 1976b, p. 88.

105. Marx 1974b, p. 290; Marx and Engels 1976b, p. 86.

106. Marx 1974b, p. 295; Marx and Engels 1976b, p. 91.

107. Marx 1974b, p. 293; Marx and Engels 1976b, p. 89.

108. Karev 1927, p. 182.

109. Marx 1966, p. 179; Marx and Engels 1976r, p. 175.

110. Marx 1966, p. 179; Marx and Engels 1976r, p. 175; Marx 1965c, p. 509; Marx and Engels 1976q, p. 139.

111. Marx 1983a, p. 250; Marx and Engels 1976n, pp. 257–8. This passage repeats several of the points that Marx made in his earlier critique of mediation, for example, about the problematic character of mediation between the *mediator* and the extremes. Christ is supposed to be a mediator between God and man, but he became more important than God. The saints became more important than Christ, and the priests more important than the saints.

this that there is no contradiction between use-value and exchange-value[112] or between industrial capital and consumers. The key point of Marx's critique of mediation of contradictions is not that mediation of a contradiction does not occur at all, but that even when the mediating links exist, they do not resolve the contradiction of the opposite sides or prevent its intensification.

The textual evidence shows that, early and late, Marx maintained that mediation only resolves apparent contradictions, not real ones, and this resolution by mediation takes place only in the realm of theories and concepts. Resolution of real contradictions requires a process called 'development', in which the contradiction becomes sharper and more intense. This is very close to Marx's conclusion in his early critique of Hegel. Since the resolution of real contradictions is one of the themes of the ellipse passage, we must review some of the evidence that Marx held this view.

Marx on mediating contradictions

The idea that a contradiction can be mediated only if it is *apparent*, rather than real, is clear in the few examples Marx gives in his works of contradictions that can actually be mediated, examples dealing mainly with contradictions within theories. He notes, for example, that zero divided by zero appears to be a contradiction, but intermediate links may be provided that show how such an expression can make sense.[113] Marx takes James Mill to task for trying to resolve theoretical contradictions 'by phrases', without finding 'intermediate links [*Mittelglieder*]' between the concrete and abstract aspects of his theory. He criticises Ricardo for trying to resolve a 'prima facie' contradiction without intermediate links.[114]

For many cases of non-theoretical contradictions, however, Marx explicitly rejected mediation. He stated that certain contradictions or oppositions are unmediated; for example, that 'The function of money as means of payment contains an unmediated [*unvermittelten*] contradiction.'[115] He ridiculed the

112. Marx 1965c, p. 509; Marx and Engels 1976q, p. 140.

113. Marx 1966, p. 325; Marx and Engels 1976r, p. 311. Presumably Marx is referring to the limit of a ratio when both numerator and denominator approach zero. For example, the limit as x approaches zero of $\sin(x)/x = 1$.

114. Marx 1965d, pp. 83–4; Marx and Engels 1976q, p. 278; Marx 1965c, p. 171, Marx and Engels 1976p, p. 401.

115. Marx 1966, p. 151; Marx and Engels 1976r, p. 148; Marx 1964a, p. 69; Marx and Engels 1976g, p. 106; '... the industrial bourgeoisie and the industrial proletariat confronted each other without mediation [*unvermittelt*]'.

'critical moralists' who 'know how to unite contradictions',[116] and rejected Roscher's account of economic phenomena as trivial, since 'the word mediation decides everything'.[117]

In his speech before the court in his 1849 trial, Marx said that there was a life-and-death struggle between the feudal and bourgeois societies, conditioned by their material interests and needs. In this struggle one must win and the other lose. 'This is the only possible mediation [*Vermittlung*] between the two',[118] an ironic use of 'mediation' that recalls Marx's criticism of Hegel for seeking to prevent the 'inflammation to a decision' between two sides of a real opposition. In the *Communist Manifesto*, Marx and Engels criticised 'utopian' socialists who tried to blunt class struggle and mediate opposites.[119] In 1879 Marx and Engels criticised the leaders of German socialism for their attempts at mediation of social oppositions instead of struggling to defeat the capitalists and the government.[120]

According to Hegel, mediation of contradictions was supposed to reconcile the two sides. As with mediation, Marx made both philosophical and political critiques of attempts to reconcile contradictions. He characterised some individual contradictions as 'irreconcilable [*unversöhnlichen*]',[121] and rejected attempts by J.S. Mill, who denied the contradictions of capitalism, to 'reconcile the irreconcilable'.[122] He ridiculed idealistic attempts at reconciliation of contradictions and oppositions.[123] Proudhon, who wanted to reconcile contradictions, should rather have asked whether the basis of these contradictions must be overthrown [*doit être renversée*].[124] Later Marx wrote that the illusion of reconciliation of parties that represent conflicting interests only promotes domination by the interests of one of the parties.[125]

116. Marx and Engels 1957a, p. 194; Marx and Engels 1976c, p. 183.

117. Marx 1965a, p. 336, n. 46; Marx and Engels 1976s, p. 322, n. 45.

118. Marx 1961b, p. 254; Marx and Engels 1976f, p. 336.

119. Marx and Engels 1959a, p. 491; Marx and Engels 1976e, p. 516.

120. Marx and Engels 1962a, p. 163; Marx and Engels 1976l, p. 267.

121. Marx 1974b, p. 290; Marx and Engels 1976b, p. 86.

122. Marx 1965d, pp. 83–4; Marx and Engels 1976q, p. 278. Marx 1966, p. 21; Marx and Engels 1976r, p. 16.

123. Marx and Engels 1958a, p. 464; Marx and Engels 1976d, pp. 475–6 (an opposition whose reconciliation is the most sought-after wish); Marx 1964d, p. 33; Marx and Engels 1976k, p. 106 (fantastic solutions of social oppositions).

124. Marx to Annenkov, 28 December 1846, in Marx and Engels 1954, p. 26; Marx and Engels 1976t, pp. 103–4.

125. Marx and Engels 1964a, p. 461; Marx and Engels 1976g, p. 530.

Development

We have already noted Marx's view that resolution of a real contradiction requires 'development'. Marx took this concept from Hegel, for whom it meant the unfolding of the inner potential of something.[126] Marx endorsed this broad conception of development as possibility becoming 'reality [*Wirklichkeit*]'[127] and applied it to some things other than contradictions that undergo development, such as the forces of production and commodity relations.

Marx's conception of the development of real contradictions appears to involve at least three features: (1) becoming simpler, (2) becoming more apparent, and (3) becoming sharper, more intense, or being 'driven to a peak'. We will briefly discuss how each of these features appear in Marx's texts.

Simplification and intensification are both cited as features of development in a passage in the *1844 Manuscripts*. There, Marx described the transformation of landowners into capitalists as a 'movement of reality' that 'will simplify the opposition [between labour and capital], drive it to a peak and therefore accelerate its resolution [*Auflosung*]'.[128] In the *Communist Manifesto*, the bourgeois epoch is described as one that 'has simplified class oppositions. Society is more and more split into two great hostile camps, into two great classes directly confronting one another', which eventually leads to the 'forceful overthrow' of the bourgeoisie.[129] The division of Germany and Austria into separate countries took place by simplification of various oppositions.[130]

Developing oppositions and contradictions also tend to become more apparent. The contradictions of the lawgiving power in bourgeois society are '*driven into appearance*'.[131] In a crisis of the world market, 'the most developed phenomenon of capitalist production', the 'contradictions and oppositions of bourgeois production become striking [*bringen ... zum Eklat*]'.[132]

The aspect of development that Marx most emphasises is intensification. Here are a few of numerous instances: A 'sharper and deeper [*schärfer und tiefer*] opposition ... develops all the more';[133] 'driven to a peak [*auf die Spitze getrieben*], this opposition is necessarily the peak, the limit [*Höhe*] and

126. See Inwood 1992.
127. Marx 1966, p. 128; Marx and Engels 1976r, p. 124.
128. Marx 1990, p. 525; Marx and Engels 1976b, p. 285.
129. Marx and Engels 1959a, pp. 463, 473; Marx and Engels 1976e, pp. 485, 495.
130. Marx 1964c, pp. 524–5; Marx and Engels 1976i, p. 168.
131. Marx 1974b, p. 295; Marx and Engels 1976b, p. 91.
132. Marx 1965c, pp. 500, 502; Marx and Engels 1976q, pp. 131, 132.
133. Marx and Engels 1958a, p. 48; Marx and Engels 1976d, p. 61.

the destruction [*Untergang*] of the whole relationship'.[134] 'This opposition becomes sharper every day [*täglich schärfer*] and pushes toward a crisis.'[135]

A reasonable interpretation of increased intensity or sharpness of a contradiction is an increase in the mutual interference of the two sides. As the contradiction undergoes the fullest possible development and nears resolution, this interference is increased to such an extent that the two sides cannot coexist any longer, and one must defeat the other, either by destroying it or by weakening it so completely that it can no longer interfere with the victorious side.

Marx does not appear to have made a categorical claim that real contradictions can only be resolved by development, but he does make statements from which this is a reasonable conclusion. In the *1844 Manuscripts*, he claims that development does in fact lead to resolution. There he wrote that opposition of capital and labour is 'private property as its developed relation of contradiction, hence [*darum*] an energetic relation driven to resolution [*Auflösung*]'.[136] Here the term 'hence' indicates that the resolution takes place *because* the contradiction is developed.

In a number of specific cases Marx claims that development is a necessary condition for the resolution of real contradictions. In *Capital*, Volume 1, he wrote: 'The development of the contradictions of an historical form of production is, however, the only historical path of their resolution [*Auflösung*] and new formation.'[137] Marx and Engels ridiculed Bruno Bauer for presenting a contradiction as having 'found its resolution not in the course of its development [*fand seine Auflösung nicht im Lauf ihrer Entwicklung*]' but in 'elements' that already existed independently of the contradiction.[138] Part of the case for the inevitability of proletarian revolution in the *Communist Manifesto* is the claim that 'the development of class opposition keeps step with the development of industry',[139] so that the intensification of that opposition is inevitable.

We have found Marx rejecting resolution of contradictions by mediation – except in some theoretical cases – and asserting resolution by development for many instances and some general categories of real contradictions and oppositions. The most reasonable interpretation of his views on this topic is the one already mentioned, that real contradictions or oppositions are resolved by development. The ellipse passage also asserts that motion is required for

134. Marx 1990, p. 525; Marx and Engels 1976b, p. 285.
135. Marx and Engels 1958a, p. 457; Marx and Engels 1976d, p. 469.
136. Marx 1990, p. 533; Marx and Engels 1976b, p. 294.
137. Marx 1966, p. 512; Marx and Engels 1976r, p. 491.
138. Marx and Engels 1957a, p. 111; Marx and Engels 1976c, p. 105.
139. Marx and Engels 1959a, p. 490; Marx and Engels 1976e, p. 515.

resolution of actual contradictions. It might be reasonable to add motion as a fourth feature of development, or to regard it as an additional condition for resolution of real contradictions.

'Real contradictions' are not limited here to contradictions in society or nature, but also might include some contradictions in theory, since Marx mentions contradictions in a theoretical trend that undergo development.[140] The majority of the real contradictions whose resolution he discusses, however, are not theoretical, including the ellipse case that concerns us here. If the thesis defended here is correct, that real contradictions are only resolved by development but some (apparent) theoretical contradictions can be resolved by mediation, then Marx's dialectics, considered as a logic of concepts, and his dialectics as an explanation of real historical change have some significant differences, since the former permits both sides to be preserved while the latter involves defeat or destruction of at least one side.[141]

Details of the ellipse passage

The central interpretative problem of the ellipse passage is the meaning of the assertion that elliptical motion solves [*löst*] an actual contradiction but does not overcome [*aufhebt*] it. Exploring this idea requires a closer examination of Marx's terminology.

In various texts, Marx used all of the terms 'lösen', 'auflösen', and 'aufheben' to describe the resolution of a contradiction. The meaning of the term 'overcome [*aufheben*]' is fairly straightforward. Generally it means to cancel, but in a few cases Marx seems give it Hegel's sense of both cancelling and also preserving in a modified form.[142] If a contradiction is overcome, it ceases to be a contradiction.

The other terms are more problematic. In ordinary German, 'lösen' means solving a problem or a difficulty, or loosening something. 'Auflösen' means to dissolve, resolve or disintegrate. Parallel to 'aufheben', a resolved contradiction

140. 'Political economists themselves occasionally feel these contradictions, and the development of them forms the principal content of their mutual struggles.' (Marx and Engels 1957a, p. 34; Marx and Engels 1976c, p. 33).

141. The issue here is the difference between the logical dialectics of theories containing contradictions that are apparent but not essential, and the resolution of real contradictions that are undergoing historical development. This is quite different from the so-called 'logical-historical method', which concerns the relation of the dialectical structure of Marx's *Capital* to the historical evolution of capitalism. See Arthur 1997.

142. See, for example, Marx 1992, p. 504, cf. Marx 1965a, p. 456; Marx and Engels 1976s, p. 438, where Marx writes of an opposition's being 'positively overcome [*positiv aufgehoben*]'.

is no longer a contradiction.[143] Unfortunately it is difficult to find in Marx any systematic difference in the use of 'lösen', 'auflösen', and forms deriving from them, to describe processes taking place in contradictions. Marx used 'lösen' more often to describe the elimination of theoretical contradictions,[144] but he also sometimes used that term to describe the resolution of economic and political contradictions.[145]

Marx's typical usage of 'lösen', 'auflösen', and 'aufheben' seems to make them synonymous when applied to contradictions. Doing so in the ellipse passage, however, would produce an absurdity. 'Lösen' must at least be different from 'aufheben', since otherwise Marx would be flatly contradicting himself by asserting one and denying the other. Several authors have concluded that 'lösen' must not mean 'auflösen' in that context. Andreas Arndt, for example, has identified *lösen* with removal of a contradiction while preserving the totality that provides the conditions for its existence. He identifies *auflösen* with the removal of the contradiction by the breaking up of that totality. Christian Iber has claimed that, for Hegel and Marx, a real contradiction can be 'coped with or solved [*bewältigt oder gelöst*]', but not overcome by theoretical development.[146]

By using 'lösen', Marx is at least asserting that the contradiction between two tendencies of motion is sustained, and not subject to immediate resolution. My best guess is that for Marx, elliptical motion 'solves' the contradiction by constituting a *partial* realisation of both of the two contradictory tendencies, which cannot both be fully realised because of their incompatibility. That is, the gravitational tendency is partially realised since the planet or satellite moves nearer to the central body than it would if gravity were absent, but does not actually hit the central body. The tangential tendency is partly realised, since motion in the tangential direction takes place, but only within limits.

The French version

Comparing the German and French versions of the ellipse passage throws some light on the significance of 'lösen'. Marx worked over J. Roy's French translation extensively.[147] He found it too literal and revised it for readability;

143. Marx and Engels 1957a, p. 111; Marx and Engels 1976c, p. 105.

144. For example, see Marx 1965c, p. 453; Marx 1965d, pp. 87, 176; Marx and Engels 1976q, pp. 87, 281, 360.

145. See for example, Marx 1963, p. 32; Marx and Engels 1976o, p. 288; Marx 1964b, p. 205; Marx and Engels 1976g, p. 248.

146. Arndt 1994, pp. 305–6; Iber 1990, p. 493, n. 26.

147. See, for example, Marx to Sorge, 23 May 1872, Marx and Engels 1976v, p. 377. On Marx's role in editing the French version, see Marx 1989b, pp. 717–24.

the revisions were extensive enough that he claimed that the French version had a scientific value independent of the original.[148] Here is a translation of the French version of the ellipse passage:

> The exchange of commodities cannot, as one has seen, take place without fulfilling contradictory conditions, which exclude one another. Its development, which makes commodities appear as something with two aspects, use-value and exchange-value, does not make these contradictions disappear [*ne fait pas disparaître*], but creates the form in which they can move themselves. This is in any case the only method for resolving [*resoudre*] real contradictions. It is, for example, a contradiction that a body should fall constantly toward another, and also constantly fly away from it. The ellipse is one of the forms of movement by which this contradiction realises itself and resolves itself [*se résout*] at the same time.[149]

The underlined words do not correspond to words in the German text. The 'overcome' versus 'solved' distinction is preserved here by Roy and Marx, using 'make disappear [*fait disparaître*]' for 'aufheben' and 'resolve itself [*se résout*]' for 'lösen'.[150]

The Aveling-Moore English translation

Although it was prepared after Marx's death and thus gives no direct evidence of Marx's intentions in the ellipse passage, it is worthwhile noting the remarkably inaccurate and misleading character of the Aveling-Moore translation of the ellipse passage, the version followed in the English *Marx/Engels Collected Works*. Here is that translation:

148. Marx 1966, pp. 31–2; Marx and Engels 1976r, p. 24.

149. 'L'échange des marchandises ne peut, comme on l'a vu, s'effectuer qu'en remplissant des conditions contradictories, exclusives les unes des autres. Son development qui fait apparaître la marchandise comme chose à double face, valeur d'usage et valeur d'échange, ne fait pas disparaître ces contradictions, mais crée la forme dans laquelle elles peuvent se mouvoir. C'est d'ailleurs la seule méthode pour resoudre des contradictions réelles. C'est par example une contradiction qu'un corps tombe constamment sur un autre et cependant le fuie constamment. L'ellipse est une des formes de mouvement par lesquelles cette contradiction se réalize et se résout à la fois.' (Marx 1989a, pp. 80–1.) The words 'qui fait apparaître la marchandise comme chose à double face, valeur d'usage et valeur d'échange [which makes the commodity appear as something with two aspects, use-value and exchange-value]', which were added in the French version, indicate that Marx takes the development of commodities to include the development of contradictions within them.

150. The standard Russian and Chinese translations of the ellipse passage also preserve an overcoming/solving distinction, as 'snimaet/rasreshaetsia' and 'yangqi/jiejue', respectively. Marx 1960, p. 114; Marx 1975, p. 122.

> We saw in a former chapter that the exchange of commodities implies contradictory and mutually exclusive conditions. The differentiation of commodities into commodities and money does not sweep away these inconsistencies, but develops a *modus vivendi*, a form in which they can exist side by side. This is generally the way in which real contradictions are reconciled. For instance, it is a contradiction to depict one body as constantly flying towards another, and as, at the same time, constantly flying away from it. The ellipse is a form of motion, which, while allowing this contradiction to go on, at the same time reconciles it.[151]

There are at least three ways in which this translation is incorrect. The phrase that these contradictions 'develop a *modus vivendi*, a form in which they can exist side by side' renders a German phrase which actually says that the contradictions create a form in which they can move. The terms '*modus vivendi*' and 'exist side by side' are glosses, not translations, and movement, which is a key point of this passage, is not adequately rendered by 'modus vivendi', which suggests accommodation, not motion. Second, 'lösen' is twice translated as 'reconciliation', which is surely incorrect. The German term for reconciliation is 'versöhnen', not 'lösen', and both Marx and Engels polemicised against the idea that real contradictions can be reconciled. Third, the phrase 'it is a contradiction to depict' conveys an idea directly opposite to the assertions of the German text. The contradiction is not only in the *depiction* of elliptical motion; it is in the motion itself. This is the clear sense of the German text's assertions that the contradictions are 'real [*wirklich*]', are 'actualised [*verwirklicht*]', and that the sides of the contradiction are the two tendencies of motion that are mentioned, not their depictions.[152] Other passages in the Aveling-Moore version of *Capital*, Volume 1, that use dialectical terminology are also not sufficiently accurate for use in philosophical discussion.[153]

It is puzzling that Engels, who worked over this translation in detail,[154] would allow such a defective English version to be published. Engels was not happy with the dialectical development in the early part of *Capital*, Volume 1. He preferred a more historical presentation, and maintained that '... the philistine [reader] is not used to this kind of abstract thought and will certainly not be pleased to torture himself for the sake of the form of value'.[155] Later he wrote to Marx that in the English translation of *Capital*, 'what is inevitably lost

151. Marx and Engels 1976r, p. 113.

152. Unfortunately, this 'depicted as' translation has also been adopted in Ben Fowkes's generally very good translation, in Karl Marx 1976a, p. 198.

153. Compare, for example, the insertions and omissions in the English text, Marx and Engels 1976r, pp. 123–4, with the German original in Marx 1966, pp. 127–8.

154. See Engels to Laura Lafargue, 28 April 1886, Marx and Engels 1976w, p. 436.

155. Engels to Marx, 16 June 1867, in Marx and Engels 1954, p. 135; Marx and Engels 1976u, p. 381.

in the really dialectical places' could be made up on other subjects.[156] It seems that Engels had very low expectations for an accurate and comprehensible English translation of dialectical passages from *Capital*. The ironical result is that although Engels has been accused of importing the dialectics of nature into Marxism, the translation he edited obscured an important example of it in the English version of *Capital*.

Resolution in the ellipse passage

We have seen that Marx claimed that development is a necessary condition for the resolution of real contradictions. In the ellipse passage, however, Marx denies that development of the commodity form overcomes its contradictions, but only solves them. This remark suggests that development is not a sufficient condition for resolution of a real contradiction.

The comparison with elliptical motion follows immediately, where the contradiction in elliptical motion is said not to be overcome, although it is not claimed to be developed or developing.[157] Does this mean that some real contradictions do not develop or move toward resolution? Several authors have proposed this interpretation.[158] In his discussion of the ellipse passage, Hubert Horstman has claimed that it shows that for Marx, '[n]ot every contradiction drives toward resolution'.[159]

Chinese philosopher Hu Zhengping goes further than Horstman and claims that there is a mode of resolution of contradictions called 'dynamic equilibrium [*dongtaipingheng*]'. Hu considers this a contribution to the project that dominates dialectical philosophy in China today, that of harmonising social contradictions, in particular, 'combining a market economy with socialism'.[160] Both Hu's and Horstman's views are part of a trend of dialectical thought in Russia and China dating back to the 1930s, a trend that claims there is a special kind of 'non-antagonistic' contradiction, including all the social contradictions of socialism, that does not tend to become more intense.[161]

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156. Engels to Marx, 29 November 1873, Marx and Engels 1954, p. 222, Marx and Engels 1976v, p. 541.

157. The assertion of development for the commodity is clear both in the German and French versions, but the French adds that the commodity's development 'makes commodities appear as something with two aspects, use-value and exchange-value.' Thus development brings out the contradiction between two aspects of value. It is also clear in both versions that *movement* is said to be the method by which contradictions are solved (but not overcome), not development.

158. Horstman 1986, p. 69; Arndt 1994, pp. 305–6; Iber 1990, p. 493, n. 26.

159. Horstman 1986, p. 69.

160. Hu 2006b, p. 30.

161. On the non-antagonistic contradiction concept, see Weston 2008.

The ellipse passage is the whole of the slender evidence Hu finds in Marx for dynamic-equilibrium resolution, which he explains as follows:

> It [the dynamic-equilibrium mode of resolving contradictions] differs from the mode of one side [of the contradiction] annihilating the other or of one side overpowering the other. It forms a kind of comparatively harmonious [*xietiao*] pattern of motion in the interaction of both sides. These intrinsic contradictions are not overcome [*yangqi*], but still exist while they *do not intensify* [*jihua*] *at all*. They [the two sides] remain dependent on each other and supplement each other, but although they have opposition and a struggle in which the expansion of one eliminates the other, both sides are also in a continuous process of resolution [*jiejue*] of the contradictory motion, achieving a greater balance and coordination overall, thus realising at a certain stage a thing's higher development of dynamic equilibrium.[162]

Why Hu regards dynamic equilibrium as a mode of *resolution* of contradictions is something of a mystery, since he admits that a contradiction subject to it continues to exist. A contradiction is not resolved by finding a compromise or an optimal adjustment between the opposing sides, as long as those sides continue to exist and interfere with each other. Hu appears to describe the *solution*, not the *resolution* of a contradiction. In any case, both Horstman and Hu believe that Marx sees some actual contradictions as lacking the tendency to develop. Let me explain why I believe this conclusion is not warranted by the ellipse passage.

First let us notice that there are two contradictions – or perhaps types of contradiction – in the ellipse passage, those involving the circulation of commodities and those realised in elliptical motion. Marx made clear that contradictions between use-value and exchange-value, or between commodities and money, are capable of becoming very intense and causing crises.[163]

Marx may also have had this view of planetary motion. It was a widely circulated view in nineteenth-century England that the solar system would eventually run down. Earth's orbit around the Sun, for example, might eventually decay and lead to the end of its (nearly) elliptical orbit. A comment by Marx in *Capital*, Volume 1, shows that he was aware of this idea.[164] Engels actually held this view a few years later, claiming that the Earth would 'circle in constantly narrower orbits' around a 'dying Sun' and finally fall into it.[165] If Marx agreed with this – and we do not know that he did – it would be quite

162. Hu 2006b, p. 32, emphasis added.

163. See, for example, Marx 1965c, p. 510; Marx and Engels 1976q, p. 140.

164. Marx 1966, p. 285; Marx and Engels 1976r, p. 275. Marx wrote that capitalists are no more concerned with depopulation than with the possible fall of the Earth into the Sun.

165. Engels 1968b, p. 324; Marx and Engels 1976m, p. 332.

consistent with the ellipse passage to conclude that both the contradictions in the circulation of commodities and in elliptical motion, while not necessarily becoming more intense or driving toward resolution at every moment, would eventually do so.

The ellipse passage says nothing about decay or intensification, and Marx is silent on whether or how the contradiction in elliptical motion might end. The conclusions of Horstman and Hu are supported by the ellipse passage only if this silence could be taken as evidence of Marx's view that intensification or driving toward resolution would not happen in an actual system undergoing elliptical motion. I think that Marx's silence on this point does not constitute such evidence, and examining Marx's reasons for introducing the topic of elliptical motion helps show this.

Marx's use of dialectical examples from nature

It is clear from the ellipse passage that Marx is making use of an example of a contradiction in nature both to illustrate a general assertion about contradictions and motion, and to make a point about contradictions in the circulation of commodities. Using the ellipse case to do this would make no sense at all unless Marx assumed that natural processes have dialectical features and that his readers would accept this fact.

Besides the ellipse passage, Marx used a similar argumentative strategy in several other places. In the *Grundrisse*, he criticised a superficial and excessively abstract way of describing buying and selling, making an argument by analogy against it in this way: '... thus it is the same as it would be to maintain that there is no difference, much less opposition and contradiction, between natural bodies [*zwischen den Naturkörpern*], since they, for example, are grasped in the determination of weight, and all are heavy and thus are equal; or are equal since they all take up three-dimensional space'.[166] Here the existence of opposition and contradiction between natural bodies is taken for granted in order to argue that it is incorrect to deny opposition and contradiction in buying and selling. This argument is similar enough to that made later in the ellipse passage that it may actually be an early version of that passage.

The pattern of analogy in which a natural opposition is taken for granted also appears in a remark by Marx about magnetism in *Capital*. Discussing the oppositions that he has brought out within the forms of commodities, Marx notes that such oppositions are not obvious: 'People do not by any means regard the general immediate form of exchangeability as an oppositional

166. Marx 1983a, p. 173; Marx and Engels 1976n, p. 179.

commodity form, one that is just as inseparable from the form of non-immediate exchangeability as the positivity of one pole of a magnet is from the negativity of the other pole.'[167] This passage and some others make it clear that Marx thought that there was opposition in a magnet.[168]

Although these passages and the ellipse passage would not make sense if Marx were not assuming that there are contradictions and oppositions in nature, the point of his argument is about economics, or, in the ellipse passage, about economics and dialectics. Thus Marx did not give any more detail about the interpretation of his physics examples than is necessary to make these points. Indeed his rhetorical strategy only works if the physical facts are taken for granted. Thus it is not reasonable to make inferences about Marx's interpretation of the dialectical features of the physics in these examples based on what he *omits*. That is the inference, however, which is required by Horstman's and Hu's interpretations.

Conclusion

Whether the arguments above prove that Marx saw dialectics in nature depends in part on what dialectics is. Marx himself saw contradiction as the central concept of dialectics. In *Capital*, Marx wrote that 'Hegelian "contradiction" is the source [*Springquelle*] of all dialectics.'[169] So if there are contradictions in nature, then there is dialectics in nature, as Marx understood dialectics.

Lukács gave his own list of the most essential features of dialectics, and contradiction was not among them.[170] Hence he might have argued that there is no dialectics of nature in *his* sense. Obviously this would not constitute evidence that Marx differed from Engels on this issue.

In this paper, we have only mentioned Engels's views in passing. Engels wrote quite a bit on the question of elliptical motion, however, and his focus and his views are somewhat different from Marx's. In particular, Engels pursued Hegel's argument that there is no tangential tendency of motion (that is, inertia) in elliptical motion.[171] Nothing we have from Marx shows concern with this aspect of Hegel's argument. Engels's views on this subject might make an appropriate topic for further study.

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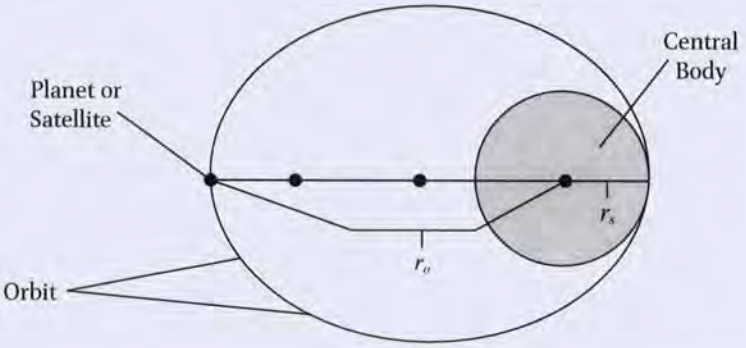
167. Marx 1966, p. 82, n. 32; Marx and Engels 1976r, p. 79, n. 1.
168. See Marx 1974b, p. 293; Marx and Engels 1976b, p. 88.
169. Marx 1966, p. 623, n. 848; Marx and Engels 1976r, p. 592, n. 2.
170. Lukács 1968, p. 63, n. 6; Lukács 1971, p. 24, n. 6.
171. See, for example, Engels 1968b, p. 357; Marx and Engels 1976m, pp. 365–6.

Appendix



Elliptical motion occurs only when neither the inertial tendency nor the gravitational tendency is too strong or too weak in relation to the other. If the initial velocity of a planet or satellite is higher than a critical value, it will fly off into space on a hyperbolic or parabolic trajectory. This critical value is called the *escape velocity*, v_{esc}. If the mass of the planet or satellite is small compared to the mass M of a central body, G is the gravitational constant, and r_0 is the initial distance from the central body, then

$$v_{esc} = \sqrt{\frac{GM}{r_0}} \quad [172]$$

In order for the planet or satellite to fall into the central body on a 'suborbital' path, its tangential velocity must be smaller than a critical value v_0. To calculate v_0, we calculate the parameter *e*, the eccentricity of the ellipse, which is defined as:

$$e = \frac{(r_0 - r_s)}{(r_0 + r_s)} \quad [173]$$

where r_0 is distance from the central body, and is r_S. is the radius of the central body, as shown in the diagram. We consider the simple case where the elliptical motion begins with tangential motion alone, with no initial motion toward or away from the central body. In that case,

172. Bate, Mueller and White 1971, p. 35.
173. Bate, Mueller and White 1971, p. 31, equation (1.7–4).

$$e=\frac{\left(GM-r_0 v_0^2\right)}{GM}$$ [174]

If the radius of the satellite is neglected, a simple calculation shows:

$$v_0=\sqrt{\frac{2GMr_s}{r_0\left(r_0+r_s\right)}}$$

If v_0 lies in between these two values,

$$\sqrt{\frac{2GMr_s}{r_0\left(r_0+r_s\right)}}<v_0<\sqrt{\frac{GM}{r_0}}$$

then the planet or satellite will execute sustained elliptical motion. In that case, the inertial tendency will prevent the full realisation of the gravitational tendency – falling into the central body – and the gravitational tendency will prevent the full realisation of the inertial tendency, the tendency to fly off to infinity. Thus the two tendencies interfere with each other, and represent a contradiction.

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174. Geyling and Westerman 1971, p. 13, equation 2.2.3, with $y_0=0$ and $\mu=GM$.

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