

Inhaltsverzeichnis

<i>Editorial</i>	5
Marx, Engels und utopische Sozialisten	
<i>Danga Vileisis: Marx' frühe, utilitaristische Auffassung des Kommunismus</i>	9
<i>Jan Hoff: Kenntnislücken in Marx' Rezeption antikapitalistischer Autoren der 1820er Jahre – drei Fallbeispiele</i>	39
<i>Carl-Erich Vollgraf: Marx und Engels bis zuletzt in utopischen Dimensionen</i>	53
<i>Michael Brie: Die Spuren Robert Owens und der Oweniten im Werk von Marx und Engels. Eine Skizze</i>	93
<i>Nadja Rakowitz: Der falsche Bruder des Kommunismus. Marx' Kritik an Pierre-Joseph Proudhons Utopie von Freiheit und Gleichheit</i>	132
<i>Bertel Nygaard: Der wichtigste kommunistische Anführer. Wilhelm Weitling und die frühe Arbeiterbewegung</i>	167
<i>Alexander Amberger: Die Entwicklung des Sozialismus von der Utopie zur Wissenschaft – Bemerkungen zur Verbreitung, Interpretation und Auswirkung auf den Utopiebegriff in der DDR</i>	187
<i>Kaan Kangal: Marx and Engels on Planetary Motion</i>	202
Aus der Editions- und Nachlassgeschichte	
<i>Hans-Joachim Blank: Zur Dissertation von Karl Marx. Über ihre Überlieferungs-, Editions- und Entstehungsgeschichte</i>	225
<i>Gerd Callesen: Die Überführung des Nachlasses von Marx und Engels nach Kopenhagen 1933</i>	255
Mitteilungen	
<i>Michael Sommer: Wo Das Kapital wirklich erschien. Meissners Verlagshaus in Hamburg</i>	265

<i>Shuang LIANG: From Concept to Practice: The Logic of the Berlin Ideological Evolution of “Utopia 500”</i>	269
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Rezensionen

<i>Amy E. Wendling: The Beautiful Music: A Review of Rachel Holmes’s Eleanor Marx: A Life</i>	279
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<i>Gabriele Schimmenti: Giovanni Sgro’: MEGA-Marx. Studi sulla edizione e sulla recezione di Marx in Germania e in Italia</i>	287
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<i>Georgios Stamatis: Einige problematische Stellen in der ersten, zweiten, dritten und vierten Auflage des ersten Bandes und im dritten Band des <i>Kapitals</i></i>	291
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Contents	295
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Bitte beachten Sie die Hinweise auf Neuerscheinungen anlässlich des 150. Jahrestages des ersten Bandes des *Kapitals*: S. 52, 186, 268.

Kaan Kangal

Marx and Engels on Planetary Motion

For decades, the question of whether dialectics applies to nature has been a hotly debated topic in the Marxian literature. A number of authors have claimed that the Marxist outlook on nature and natural sciences has been formulated by Engels alone. According to this view, Marx, unlike Engels, was concerned not with trans-historical laws governing the universe but with some particular laws of society. This anti-Engels camp, so to speak, mainly tended to draw bold lines between Marx and Engels, and charged Engels with distorting Marx's original ideas of dialectics by some kind of reductionism, scientism and positivism that might also end up in an obsolete idealism.¹ Engels was „following Hegel's mistaken lead“ by extending „the method to apply also to nature“. However, dialectics was „limited ... to the realms of history and society“.² Some others objected to this view, and characterized any attempt to sharply contrast Engels with Marx as concealed mysticism and ideal-

¹ Jean-Paul Sartre, *Critique of Dialectical Reason. Volume 1. Theory of Practical Ensembles* (London: Verso, 2004), 26-7; George Lichtheim, *Europe in the Twentieth Century* (New York: Praeger, 1972), 212; Lucio Colletti, *Marxism and Hegel* (London: NLB, 1973), 46; Alfred Schmidt, *Der Begriff der Natur in der Lehre von Marx* (Hamburg: Europäische Verlagsanstalt, 1993), 46, 55-6.

² Georg Lukács, *History and Class Consciousness: Studies in Marxist Dialectics* (Cambridge: MIT, 1971), 24, n. 6. In his 1925/26 defense, Lukács defended an opposite view that there are dialectical laws governing nature. See Georg Lukács, „Chvotismus und Dialektik“, *Jahrbuch der Internationalen Lukács-Gesellschaft* (1998/99): 127-28. In 1960s he admitted his early controversy and wrote that he deems *History and Class Consciousness* an „overcome book“. See Georg Lukács, „Zweites Gespräch. Georg Lukács – Leo Kofler. Gesellschaft und Individuum“, in Theo Pinkus (ed.), *Gespräche mit Georg Lukács* (Hamburg: Rowohlt, 1967), 57-8; Georg Lukács, „Zur Ontologie des gesellschaftlichen Seins. I. Halbband“, in *Georg Lukács Werke*, vol. 13 (Darmstadt: Luchterhand, 1984), 38, 395-96. Paul Burkett asserts that early Lukács did not actually deny dialectics of nature, but this is belied by Lukács's late self-criticism itself. See Burkett, „Lukács on Science: A New Act in the Tragedy“, *Historical Materialism*, 21, 3 (2013): 3. Ironically, Burkett writes elsewhere that „Lukács did not apply the dialectic to nature *as well as* society, in fact he viewed the application of dialectical method to nature as a concession to positivism“. See Paul Burkett, „Marx's Ecology and the Limits of Contemporary Ecosocialism“, *Capitalism Nature Socialism*, vol. 12, 3 (2001): 130.

ism.³ For the pro-Engels camp, Engels's conception of nature was „in full conformity“ with Marx's materialist philosophy.⁴ Dialectics of nature was „no invention of Engels“. On the contrary, „it was worked out in collaboration with Marx and had his full agreement“.⁵

Later, this idea was contested by the argument that „the Marx-Engels correspondence does not corroborate the traditional account of their ‘close collaboration’“ because „Marx did not discuss Engels's dialectical laws, ... nor did he say anything to substantiate the contention that he and Engels were joint expositors of a universal materialism“.⁶ This position was then accused of falsifying the fact that Marx strongly endorsed Engels's studies on dialectics of nature and „took a strong interest in science and regarded a dialectics of nature as essential to his theory of a unified science“.⁷

Regarding the critics of Engels, we still witness the same line of reasoning in recent literature that different components and internal structures of nature and society disable us to subsume a unified dialectics valid in both spheres of life. Natural laws are seemingly not utterly subordinated to human volition and consciousness. „This is why Engels's dialectics of nature cannot be applied to society.“⁸ In other words, Marx, unlike Engels, „does not treat dialectical laws as forces in nature (e.g., as gravity)“.⁹

This entire discussion seems to cluster around a rather unfruitful issue of whether Engels earned his place in Marxism or not, in general, and whether Marx would agree with Engels that dialectics applies to nature or not, in particular. The usual method involved here is to quote the relevant material from original sources, and to reintegrate the alleged evidence to the interpretive framework. It is obvious that the ultimate outcome of this debate would even-

³ A. Deborin, „G. Lukach i ego kritika marksizma“, *Pod Znamenem Marksizma*, 6-7 (1924): 49. For the pro-Engels camp see R. K. Kirchhoff and T. I. Oiserman (ed.), *100 Jahre „Anti-Dühring“*. *Marxismus, Weltanschauung, Wissenschaft* (Berlin: Akademie, 1978); Sebastiano Timpanaro, *On Materialism* (London: NLB, 1975), 74.

⁴ V. I. Lenin, „Karl Marx. A Brief Biographical Sketch with an Exposition of Marxism“, in *Lenin Collected Works*, vol. 21 (Moscow: Progress Publishers, 1974), 51.

⁵ John Hoffman, *Marxism and the Theory of Praxis* (London: Lawrence & Wishart, 1975), 56.

⁶ Terrell Carver, „Marx, Engels and Dialectics“, *Political Studies*, Vol. XXVIII, No. 3 (1980): 360.

⁷ John L. Stanley and Ernst Zimmermann, „On the Alleged Differences Between Marx and Engels“, *Political Studies*, XXXII (1984): 226.

⁸ Guglielmo Carchedi, „Mathematics and Dialectics in Marx: A Reply“, *Science & Society* 76, 4 (2012): 547. Also see Guglielmo Carchedi, *Behind the Crisis. Marx's Dialectics of Value and Knowledge*, (Leiden: Brill, 2011), 37-8.

⁹ Paul Paolucci, *Marx's Scientific Dialectics. A Methodological Treatise for a New Century* (Leiden: Brill, 2007), 245.

tually turn into a yes-or-no question, whereby the circumstantial evidence supposedly wins the argument. The reason that I consider this quarrel as unfruitful is the fact that the political and scientific legacy of Marx and Engels lapses into a mere battle of quotes. I personally prefer to keep Marx's natural scientific studies in mind, particularly those on astronomy, chemistry, biology, physiology, geography and mathematics in this regard.

Few examples from chemistry and astronomy, as I shall demonstrate below, will make clear that Marx had a concept of dialectics of nature. However, I call this 'the easy problem' of dialectics of nature, for it does not require anything more than, and is limited to, detecting the evidence and reinforcing the argument that dialectics applies to nature. 'The hard problem', on the other hand, consists in finding out the interrelations of different spheres of social and natural life, for instance between social mode of production, agricultural chemistry and natural environment. But instead of deeply focusing on rather well-known figures such as Wilhelm Hofmann, Justus von Liebig and Carl Schorlemmer from chemistry,¹⁰ I will draw attention to Marx and Engels's less noticed astronomy studies, particularly to those on planetary motion. The case of planetary motion is worth studying for a few reasons: 1) it clearly shows that Marx understood planetary motion from a dialectical vantage point; 2) it demonstrates some agreements and differences between Hegel and Marx, on the one side, and between Marx and Engels, on the other; and 3) it represents a nodal point of cosmology and ecology. This inquiry will also help us to shift the old debate from a problem of *placing* to a matter of *defining* natural dialectics within the proper context. If dialectics is „the science of universal interrelation“,¹¹ as defined by Engels, then the case of planetary motion will be the right place to examine it.¹²

But before that, I would like to take a short look at Marx and Engels's understanding of chemistry because it clearly shows how they developed their interdisciplinary approach to dialectics of nature and society. This is less obvious in the case of astronomy, for it was, and still is, an open question how astronomy is, or might be, related to planetary ecology. The case of planetary motion is important not only because it documents another significant field of

¹⁰ See John Bellamy Foster, *Marx's Ecology. Materialism and Nature* (New York: Monthly Review Press, 2000); John Bellamy Foster and Paul Burkett, *Marx and the Earth. An Anti-Critique* (Leiden: Brill, 2016).

¹¹ Friedrich Engels, „Dialektik der Natur“, in *Marx-Engels-Gesamtausgabe (MEGA²)*, vol. I/26, (Berlin Dietz, 1985), 293.

¹² I am indebted to Thomas Weston who brought the ellipse case to my attention. His remarks on another paper were also helpful to improve my argument.

dialectics of nature, but it also pinpoints some limits of our exact knowledge regarding the interrelationality of nature. Ergo, the planetary motion represents a true challenge to any dialectician or ecologist.

The Case of Chemistry

As a preliminary note, let us first consider the claim that „the Marx-Engels correspondence does not corroborate the traditional account of their 'close collaboration',, and that „Marx did not discuss Engels's dialectical laws“.¹³ This is the irony indeed, for the very correspondence and collaboration of Marx and Engels provide the evidence that Marx not only discussed but also approved dialectics of nature.

Take, for instance, an exchange between Marx and Engels shortly before the publication of the first edition of *Capital* in September 1867. On 16 June, Engels refers Marx to August Wilhelm von Hofmann's *Introduction to Modern Chemistry* (1866), arguing that it demonstrates the „molecule as the smallest part of matter capable of independent existence“. It is „a perfectly rational category, a 'nodal point', as Hegel calls it, in the infinite progression of subdivisions, which does not terminate it, but marks a qualitative change“.¹⁴ A few days later, Marx replies: „You are quite right about Hofmann. Incidentally, you will also see from the conclusion of my Chapter III, where I outline the transformation of the master of a trade into a capitalist - as a result of purely quantitative changes - that in the text there I quote Hegel's discovery of the law of the transformation of a merely quantitative change into a qualitative one as being attested by history and natural science alike“.¹⁵ As a matter of fact, at the end of his chapter „Rate and Mass of Surplus Value“ in *Capital* Marx mentions „the correctness of the law discovered by *Hegel* (in his *Logic*), that merely *quantitative* differences beyond a certain point pass into *qualitative* changes“.¹⁶

¹³ Carver, „Marx, Engels and Dialectics“, 360.

¹⁴ Frederick Engels, „Engels to Marx, 16 June 1867“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42 (Moscow: Progress Publishers, 1987), 382.

¹⁵ Karl Marx, „Marx to Engels, 22 June 1867“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42, 385.

¹⁶ Karl Marx, „Das Kapital. Kritik der politischen Ökonomie. Erster Band. Hamburg 1867“ in *MEGA*², vol. II/5 (Berlin: Dietz, 1983), 246. In the second edition, Marx undertakes a minor change in the corresponding footnote, where he previously called „Prof. Wurtz“ the founder of modern molecular theory. This part famously disappears in the second edition. See *MEGA*², vol. II/6 (Berlin: Dietz, 1987), 308. In the third German edition, Engels makes some additional remarks on the molecular theory for non-chemists. See *MEGA*², vol. II/8 (Berlin: Dietz, 1989), 309. Although Engels forwards Carl Schorlemmer's comment to Marx already on June 24th that Wurtz did not found

Marx clearly agrees with Engels that Hegel's dialectics applies to nature. However, this is not the chief concern of Marx's investigation in *Capital*. The real issue is the interrelation of chemistry and social mode of production. Regarding physiological potentials and limits of labor power, and the metabolic exchange and rift between nature and society, Marx famously refers to German chemist Justus von Liebig.¹⁷ Marx argues that the goal of his investigation does consist not in the „unity of living and active men with the natural, inorganic conditions of their metabolic exchange with nature“, which is self-evidently a „historical process“, but rather in the „separation between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labor and capital“.¹⁸ The metabolic exchange historically transforms into a „metabolic rift“, whereby one witnesses the „negative“ or the „destructive side of modern agricultural chemistry“.¹⁹ Engels could have easily identified this with his second and third laws of dialectics („interpenetration of polar opposites“, „development through contradiction or negation of negation“).²⁰ But the crucial point is that if there is a dialectics of nature in terms of Marx's analysis of capitalist agriculture, then the interrelations of metabolic exchange and metabolic rift are subject to it.

The Case of Astronomy

Another old belief from the anti-Engels camp is that Engels has craved to interpret the extra-human nature in the sense of a *purely objective* dialectics that relapses into a dogmatic metaphysics. Marx, by contrast, allegedly asserted that a dialectics of nature can only appear through the forms of social labor. Hence, the argument goes, Engels's mistake was ignoring the fact that there can be „no question of a dialectic of external nature, independent of men“. Claiming the opposite is „sheer nonsense“ because „[n]ature becomes dialectical by producing men“.²¹ Again, this is the irony of playing Marx off against Engels, because Marx, as I will show in a minute, claims otherwise. The entire argument of this Engels critic is based on an assumption that anything can be projected on Marx if one can get rid of Engels. That this attempt to contaminate Marx by dumping Engels would eventually fail is evident in the fol-

but only „popularized and elaborated“ the molecular theory, Marx deletes Wurtz's name in the second edition of *Capital* in 1872. See Frederick Engels, „Engels to Marx, 24 June 1867“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42, 387-8.

¹⁷ *MEGA*², vol. II/5 (Berlin: Dietz, 1983), 185, 265, 316, 410, 463.

¹⁸ Karl Marx, „Grundrisse“, in *MEGA*², vol. II/1 (Berlin: Dietz, 1981), 393.

¹⁹ Foster, *Marx's Ecology*, 155.

²⁰ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 293.

²¹ Schmidt, *The Concept of Nature in Marx*, 58, 61, 51, 59.

lowing passage in Marx's *Capital*: „It is a contradiction, for example, for one body to continuously fall into another, and just as constantly fly away from it. The ellipse is one of the forms of movement in which this contradiction is actualized just as much as it is solved“.²²

Marx refers here to the elliptical motion of planets and calls the conflicting relation of the gravitational and inertial tendencies of an orbit a contradiction. My contention is that if there are contradictions (unity of opposites) in nature, then we can speak of dialectics of nature in Engels's sense of the term.²³ For this reason, I claim that, in the ellipse case, Marx approves Engels's notion of dialectics of nature. Marx writes in *Capital* that „the source of all dialectics“ is „the Hegelian ‘contradiction’“.²⁴ For Hegel, „the motion is the existing contradiction“.²⁵ Based on Hegel's assessment of contradiction, Engels develops the idea that every moving object in nature embodies a real contradiction, including the elliptical motion of planets.²⁶

Like in the chemistry case, Marx's and Engels's common understanding of, and interest in, planetary motion is well documented in their correspondence and close collaboration. In 1865, when Marx was working on the laws of economic crisis, which was going to be published by Engels as part of the third volume of *Capital* in 1894, he writes to Engels that he „‘took the opportunity’ to ‘take up’ a little astronomy again“.

You know Laplace's theory o. the formation of the celestial Systems a. how he explains the rotation of the various bodies around their own axis, etc. Proceeding from there, a Yankee, Kirkwood, has discovered a kind of law concerning the *difference* in the rotation of the planets, which had previously appeared quite abnormal. ... between two planets there must be a point at which their power of attraction is equally strong; so that a body at this point would remain stationary between them. On the other hand, the body would fall towards one planet o. another on either side of that point. This point thus forms the limits of the sphere of attraction of the planet. ... Kirkwood concluded from this that ... a specific relationship must exist between the velocity of the planet's rotation and the breadth of the ring from which it was formed

²² Marx, „Kapital“, in *MEGA*², vol. II/5, 65. I use here Thomas Weston's translation in his article „Marx on the Dialectics of Elliptical Motion“, *Historical Materialism*, 20.4 (2012): 5-6.

²³ This view is shared by Weston, „Marx on the Dialectics of Elliptical Motion“, 4. Also note that none of the aforementioned Engels critics discuss the ellipse case.

²⁴ Marx, „Kapital“, in *MEGA*II/5, 481.

²⁵ G. W. F. Hegel, „Wissenschaft der Logik“, in *Hegel Werke*, vol. 6 (Frankfurt a. M.: Suhrkamp, 1986), 76.

²⁶ Friedrich Engels, „Anti-Dühring“, in *MEGA*², vol. I/27 (Berlin: Dietz, 1988), 318, 439.

or its sphere of attraction. ... Old Hegel made some very good jokes about the ‘sudden reversal’ of centripetal to centrifugal force, right at the moment when one has attained ‘preponderance’ over the other; e. g., centripetal force is greatest near the sun; *therefore*, says Hegel, centrifugal force is greatest, since it overcomes this *maximum of centripetal* force and vice versa. Moreover, the forces are in *equilibrium* when half way between the apsides. *Therefore* they can never depart from this equilibrium.²⁷

A few days later, Engels replies that Kirkwood’s law was new to him and Samuel Moore. He asks Marx whether the law is really proven or rather just a hypothesis.²⁸ The next day Marx answers that „there is no doubt that it explains the difference in the rotatory movements, e. g., between those of Jupiter and those of Venus, which hitherto appeared entirely fortuitous“. But he does not know how Kirkwood proves the law.²⁹

Why Study Astronomy?

Aside from the fact that Marx enjoyed studying astronomy and mathematics in his free time,³⁰ there are a few reasons to consider why Marx was interested in planetary motion *to this extent*. It is evident from the quoted passage above

²⁷ Karl Marx, „Marx to Engels, 19 August 1865“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42, 184-5. Translation modified according to *MEGA*², vol. III/13 (Berlin: Akademie, 2002), 529-30. There is no evidence about how Marx came to Kirkwood in the first place. In a correspondence in 1862, Marx mentions the astronomer Johann Heinrich von Mädler in passing, and adds that he has his book *Der Wunderbau des Weltalls, oder Populäre Astronomie*. But Kirkwood is mentioned in another work by Mädler, *Geschichte der Himmelskunde von der ältesten bis in die neueste Zeit*, vol. 2 (Braunschweig: Westermann, 1873), 442. For the Mädler book which Marx claims to have, see Karl Marx, „Marx an Engels, 28. April 1862“, in *MEW*, vol. 30 (Berlin: Dietz, 1974), 228. However, the book is not documented in both versions of Marx-Engels library list. See Kaiser and Werchan, *Ex Libris. Karl Marx und Friedrich Engels. Schicksal und Verzeichnis einer Bibliothek*; Karl Marx and Friedrich Engels, „Die Bibliotheken von Karl Marx und Friedrich Engels“, in *MEGA*², vol. VI/32 (Berlin: Akademie, 1999). The only astronomy book listed in Marx and Engels’s libraries is Giordano Bruno’s *Vom Unendlichen, dem All und den Welten* (Berlin: Lüstenöder, 1893). See *MEGA*², vol. VI/32, 172.

²⁸ Friedrich Engels, „Engels an Marx, 21. August 1865“, in *MEGA*², vol. III/13, 533.

²⁹ Karl Marx, „Marx to Engels, 22 August 1865“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42, 187; *MEGA*², vol. III/13, 34. Marx seems to confuse here Venus with Mars. See the editorial note in *Marx-Engels Werke (MEW)*, vol. 31 (Berlin: Dietz, 1965), 638.

³⁰ Karl Marx, „Marx an Engels, 11. Januar 1858“, in *MEGA*², vol. III/9 (Berlin: Akademie, 2003), 18; Karl Marx, „Marx an Engels, 23. November 1860“, in *MEGA*², vol. III/11 (Berlin: Akademie, 2005), 229; Karl Marx, „Marx an Engels, 6. Juli 1863“, in *MEW*, vol. 30, 362.

that he was studying Laplace's celestial mechanics, Daniel Kirkwood's critique of nebular hypothesis, and Hegel's interpretation of centrifugal and centripetal forces in the *Philosophy of Nature*. However, Marx's interest in astronomy goes back to his dissertation time in 1839-41. At that time, he was reading a variety of materials on philosophy of physics and astronomy, including Hegel's *Encyclopedia*,³¹ the famous Leibniz-Clarke correspondence, and Newton's gravitation theory. He commends some points in Newton's *Principia, Scholium generale* as „Well said, old Isaak Newton“ and „Bravo, old Newton!“.³² In an article in 1842 in the *Rheinische Zeitung* he informs his reader on Leibniz-Newton controversy.³³ In a column in the New York Tribune in 1853 on revolutions in China and Europe, he speaks of „the law of contact of extremes“, and refers to „the laws of Kepler“ and „Newton's great discovery“. ³⁴ In *The German Ideology*, Marx, along with Engels, claims that Newton „completed mechanics“. ³⁵

Marx's interest in planetary motion seems to reemerge in 1864-65, when he works on the law of the tendency of the rate of profit to fall. Here he comes to realize that there are tendencies of „centralization of existing capitals in a few hands“, and „counteracting tendencies, which have a continuous decentralizing effect alongside the centripetal one“. The counteracting tendencies are the reason why the centralization of capital does not immediately „bring the capitalist production to an end“. ³⁶ As a matter of fact, the capitalist accumulation

³¹ Karl Marx, „Hefte zur epikureischen Philosophie. Fünftes Heft“, in *MEGA*², vol. VI/1 (Berlin: Dietz, 1976), 111-12.

³² Bruno Kaiser and Inge Werchan, *Ex Libris. Karl Marx und Friedrich Engels. Schicksal und Verzeichnis einer Bibliothek* (Berlin: Dietz, 1967), 127. Marx's praise is related to Newton's metaphysics of the universe. Also see *A Collection of Papers, Which passed between the late Learned Mr. Leibnitz, and Dr. Clarke, In the Years 1715 and 1716. Relating to the Principles of Natural Philosophy and Religion* (London: Knapton, 1717), 51. This detail is mentioned in Weston, „Marx on the Dialectics of Elliptical Motion“, 8.

³³ Karl Marx, „Der leitende Artikel in Nr. 179 der 'Kölnischen Zeitung'“, in *MEGA*², vol. I/1 (Berlin: Dietz, 1975), 178. Engels writes in his 1844 article „The Condition of England“ that „Newton created scientific astronomy with the law of gravitation, scientific optics with the decomposition of light, scientific mathematics with the binomial theorem and the theory of infinity, and scientific mechanics with the analysis of the nature of forces“. See Frederick Engels, „The Condition of England“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 3 (Moscow: Progress Publishers, 1975), 470.

³⁴ Karl Marx, „Revolution in China and in Europe“, in *MEGA*², vol. I/12 (Berlin: Dietz, 1984), 147.

³⁵ Karl Marx und Friedrich Engels, „Die Deutsche Ideologie“, in *MEGA*¹, vol. I/5 (Glas-hütten im Taunus: Detlev Auvermann, 1970), 49.

³⁶ Karl Marx, „Ökonomische Manuskripte 1863-1867“, in *MEGA*², vol. II/4.2 (Berlin: Dietz, 1992), 315. Engels replaces Marx's expression „bring the capitalist production to an end [Klappen]“ with „bring the capitalist production to its collapse [Zusammenbruch]“ in the

process necessarily involves „contradictory tendencies“ and „contending agencies“. The „conflict of contending agencies finds vent in crises. The crises are always but momentary and forcible solutions of the existing contradictions. They are violent eruptions which for a time restore the disturbed equilibrium“. ³⁷ The contradiction consists in the „tendency towards absolute development of the productive forces“, on the one side, and in the countertendency „to preserve the value of the existing capital and promote its self-expansion to the highest limit“, on the other. This involves „the fall of the rate of profit, depreciation of existing capital, and development of the productive forces of labor at the expense of already created productive forces“. ³⁸

Despite a few similar behaviors of the countervailing tendencies both in planetary motion and the capitalist mode of production, Marx speaks of a possible end of capitalist accumulation as the result of imbalanced opposite tendencies, while he does not consider a possible disequilibrium of planetary motion in the ellipse passage. This marks a significant distinction between these two areas.

In any event, the ellipse case documents that Marx was taking the analogy between planetary motion and capitalist accumulation, seriously. But this does not explain yet why he was studying elliptical motion of planets in such detail. In my view, there are two possible reasons: 1) he was willing to offer an alternative account to Hegel’s dialectics of nature; 2) he was interested in extending the investigation of the laws of economic crises by introducing mathematical calculations, and utilized astronomy for this purpose.

In *1844 Manuscripts*, Marx summarizes Hegel’s concept of nature as a „manifestation“ (*Wiederschein*) of the „Absolute Idea“, the ultimate product of the latter’s *Greater Logic*. Hegel believed to have developed a rational system of categories that applies to every single sphere of (natural and social) life. This starts from the basic units of logical categories and ends up in externalizing and projecting essential concepts of dialectical logic into nature and society. Marx famously ridicules this attempt because „the absolute idea is nothing for itself; that only *nature* is something“. ³⁹ Hegel constantly tries to amalgamate philosophical concepts with physical subject matters. For example, he calls the gravitational fall of a body „abstract positing“, and the center

third volume of *Capital*. See Karl Marx, „Das Kapital. Kritik der politischen Ökonomie. Dritter Band. Hamburg 1894“, in *MEGA*², vol. II/15 (Berlin: Akademie, 2004), 243.

³⁷ Ibid., 245.

³⁸ Ibid., 246.

³⁹ Karl Marx, „Ökonomisch-philosophische Manuskripte“, in *MEGA*², vol. I/2 (Berlin: Dietz, 1982), 415.

of the attraction force „being-for-itself“. He also believed to have discovered a „contradiction“ between the source of gravitational force and all bodies that fall toward it.⁴⁰ This is not the kind of a contradiction Marx has in mind in the ellipse passage. On the other hand, the contradiction Marx identifies between gravitational and inertial tendencies does not fully apply to Hegel’s account, for the latter claims that inertia is not a physical law or force, but only a mere empirical coefficient.⁴¹ Nevertheless, there are a few similarities between Hegel and Marx. Hegel writes that „the gravitation contradicts the law of inertia“.⁴² Planetary bodies have a drive towards the Sun; „their direction is composed of this drive and of the tangential direction“. Hegel defines the inertial tendency as „the tangential direction“, and identifies the joint result of gravitational and tangential tendencies as „diagonal“, which is nothing but the elliptical curve Marx speaks of.⁴³

This brings us to Marx’s interest in mathematics. Several months after their exchange on Laplace and Kirkwood, Marx sends an extract to Engels where he explains some basics of differential calculus. He underlines that the „whole of differential calculus arose originally from the task of drawing *tangents* through any point on any curve“, e. g. an „ellipse“.⁴⁴ From a later exchange in 1873, we see that Marx’s intensive study on planetary motion was helpful to improve his knowledge of mathematical economics. He hopes to be able to „determine mathematically the principal laws governing crises“ by „calculating these ups and downs“ of „irregular curves“.⁴⁵ Leibniz and Newton’s names come up in Marx’s *Mathematical Manuscripts*, this time as the representatives of the so-called „mystical differential calculus“.⁴⁶ Tangents and ellipses are subject to his extensive studies „On the Differential“ and „Outlines and Excerpts on History of Mathematics and Mechanics from Poppe’s Book“.⁴⁷ Also note that the time period of some of his mathematical studies coincide with that of his last major work on the third book of *Capital*, „Surplus Rate and Profit Rate, mathematically treated“ (May-August 1875).⁴⁸

⁴⁰ G. W. F. Hegel, „Enzyklopädie der philosophischen Wissenschaften im Grundrisse. 1830. Zweiter Teil“, in *Hegel Werke*, vol. 9 (Frankfurt a. M.: Suhrkamp, 1986), 80.

⁴¹ Weston, „Marx on the Dialectics of Elliptical Motion“, 10.

⁴² Hegel, „Enzyklopädie“, *Hegel Werke*, vol. 9, 83.

⁴³ *Ibid.*, 97. Also see Weston, „Marx on the Dialectics of Elliptical Motion“, 9-10.

⁴⁴ Karl Marx, „Marx an Engels, Ende 1865 - Anfang 1866“, in *MEW*, vol. 31, 165-66.

⁴⁵ Karl Marx, „Marx an Engels, 31. Mai 1873“, in *MEW*, vol. 33 (Berlin: Dietz, 1976), 82.

⁴⁶ Karl Marx, *Matematicheskie Rukopisi* (Moskva: Izdatel’stvo „Nauka“, 1968), 168.

⁴⁷ *Ibid.*, 70, 88-90, 247.

⁴⁸ Karl Marx, „Mehrwertrate und Profitrate mathematisch behandelt“, in *MEGA*², vol. II/14 (Berlin: Akademie, 2003), 19-150.

Engels on Astronomy

Although Engels appreciated and praised Marx's mathematical studies in many occasions⁴⁹, it is obvious from his natural scientific studies that Engels, unlike Marx, did not utilize astronomy for economic-mathematical purposes but rather viewed it as an investigation field of its own. That mathematics is an integral part of astronomy is not denied by Marx, but it was Engels, not Marx, who undertook the task, though never finished, to bridge the divide between thermodynamics and astrophysics via mathematics. This is evident from his 1880 plan of *Dialectics of Nature*, where he makes an additional remark to mathematically explicate the third part on „repulsion + attraction here applied to conversation of energy. Influx of repulsion = energy“ before going into the fourth part on „gravity – heavenly bodies – terrestrial mechanics“.⁵⁰

Except Kirkwood⁵¹, Engels read not only the sources on physics and astronomy that were known to Marx (e. g. Croll, Fourier, Grove, Hegel, Kant, Kepler, Mädler, Newton), but went much further and studied almost every significant work in these fields (e. g. Boltzmann, Büchner, Carnot, Clausius, Helmholtz, Kirchhof, Joule, Mayer, Maxwell, Secchi, T. Thomson, W. Thomson, Tait).⁵² When referring to Engels's knowledge of natural science, Marx famously wrote: „I invariably follow in your footsteps“.⁵³

From a 1862 letter to Engels,⁵⁴ we know that Marx had a book by the German astronomer Johann Heinrich von Mädler on astrophysics of the universe where the elliptical motion of planets is mathematically explained,⁵⁵ a source

⁴⁹ In a letter to Friedrich Albert Lange in 1865, Engels wrote: „Hegel knew so much mathematics that none of his disciples was capable of editing the numerous mathematical manuscripts he left behind. The only man who, to my knowledge, has enough understanding of mathematics and philosophy to be able to do so is Marx“. See Frederick Engels, „Engels to Lange“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 42, 138. In the 1885 preface to *Anti-Dühring*, he writes that he is willing to publish Marx's „extremely important mathematical manuscripts“ in conjunction with his own studies on natural sciences. See Engels, „Anti-Dühring“, in *MEGA*², vol. I/27, 496.

⁵⁰ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 183.

⁵¹ I call Kirkwood an exception because he is not mentioned in *Anti-Dühring* and *Dialectics of Nature*. To my knowledge, there is also no supporting evidence that Engels even read Kirkwood's works.

⁵² Given the further material to be published in forthcoming volumes of *MEGA*, I leave open the question of Marx's sources on physics and astronomy.

⁵³ Karl Marx, „Marx to Engels, 4 July 1864“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 41 (Moscow: Progress Publishers, 1985), 546.

⁵⁴ Marx, „Marx an Engels, 28. April 1862“, in *MEW*, vol. 30, 228.

⁵⁵ Mädler, *Der Wunderbau des Weltalls, oder Populäre Astronomie* (Berlin: Heymann, 1861), 65-6, 96, 98-9, 165

which Engels extensively uses in *Dialectics of Nature*.⁵⁶ Another common source of Marx and Engels that influenced Engels's understanding of astrophysics is William Robert Grove, a judge by profession and an amateur physical scientist, who wrote *The Correlation of Physical Forces*.⁵⁷ Although Engels's references to Grove are mainly related to conservation laws of motion and energy, some passages unquoted by Engels might have gripped his attention, as well. For example in a passage on heat, Grove speaks of motion as an „immediate effect of heat“ and a „mechanically repulsive force, a force antagonist to attraction of cohesion or aggregation, and tending to move the particles of all bodies, or to separate them from each other“.⁵⁸

Heat (energy) as a repulsive force, I shall argue, is important for Engels's conception of planetary motion. But what is also remarkable is that Grove conceives of the relation of attraction and repulsion as „antagonist“. Given the date of Engels's reference to Grove, and Eugen Dühring's contestation of Marx's dialectics at that time, we can assume that Grove might have been one of the factors that triggered Engels's interest with respect to dialectics of planetary motion. The time when Grove's name first comes up in Engels's *Introduction* section of *Dialectics of Nature* coincides with the year when he starts working on *Anti-Dühring* (1876).⁵⁹ Dühring asserts that „the basic form of all actions in existence of the world and its essence“ is „the antagonism of forces“, while he identifies all contradictions as „absurdities“. ⁶⁰ Dühring simply refuses contradictions in nature, and aims to level a criticism against Marx's concept of contradiction. When responding to Dühring's attacks, Engels makes use of his previous work on contradictions in nature, and Grove, among others, is taken into account in this regard.

⁵⁶ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 57-8, 75, 80. Also note that page 75 is missing in the name register section of *MEGA*². See Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26 (Berlin: Dietz, 1985), 1061.

⁵⁷ Sven-Eric Liedman assumes that Grove was known to Marx and Engels already in the late 1850s. Liedman refers to a 1858 letter of Engels to Marx where the former speaks of a „correlation of forces“, which, according to Liedman, indicates that Engels was familiar with Grove. See Sven-Eric Liedman, *Das Spiel der Gegensätze. Friedrich Engels' Philosophie und die Wissenschaften des 19. Jahrhunderts* (Frankfurt: Campus, 1986), 82-3; Friedrich Engels, „Engels an Marx, 14. Juli 1858“, in *MEGA*², vol. III/9 (Berlin: Akademie, 2003), 182.

⁵⁸ W. R. Grove, *The Correlation of Physical Forces* (London: Longman, 1855), 35.

⁵⁹ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 77.

⁶⁰ Eugen Dühring, *Cursus der Philosophie als streng wissenschaftlicher Weltanschauung und Lebensgestaltung* (Leipzig: Heimann, 1875), 31; also quoted in Engels, „Anti-Dühring“, in *MEGA*², vol. I/27, 317.

Engels on Planetary Motion

In *Dialectics of Nature*, Engels acknowledges Hegel and Marx's criticism of Newton's ambiguous term 'centrifugal force' (inertial force), and adopts Marx's notion of elliptical contradiction.⁶¹ His account also involves some nineteenth-century debates on the apocalyptic end of elliptical orbits and solar system. We know from *Capital* that Marx was also aware of this issue even if he mentions it in passing when he writes that capital is no more concerned with „coming degradation and final depopulation of the human race, as by the probable fall of the earth into the sun“.⁶² A similar analogy is present in *Anti-Dühring*:

The capitalist mode of production moves in these two appearance forms of the contradiction immanent to it from its very origin. It is never able to get out of that 'vicious circle' ... this circle is gradually narrowing; that the motion presents rather a spiral, and must reach to its end, like the motion of the planets, by collision with the center.⁶³

In a passage on the heat death hypothesis in *Dialectics of Nature*, Engels writes that earth will „circle in deeper darkness and in an ever narrower orbit around the equally extinct sun, and at last fall into it. Other planets will have preceded it, others will follow it“.⁶⁴ This narrative relies on cosmological postulates that were widely circulated by some pioneering nineteenth-century scientists such as Helmholtz, Mädler, Mayer, Thomson and Tait.

In his 1854 lecture on the *Interaction of Natural Forces*, Helmholtz asserts that the ellipses of comets around the sun become „ever narrower“, and „a time will come when the comet will strike the sun, and a similar end threatens all the planets“; „they must ... approach the sun“.⁶⁵ In 1874 edition of his *Mechanics of Heat*, Mayer claims that the resisting medium in all space would cause the „planetary bodies to rotate in ever narrower orbits around the sun and at last fall into it“.⁶⁶ Mädler points out in *The Wonderwork of the Universe* that the elliptical orbit of a planet necessarily changes if there is an external distortion increasing or decreasing the tangential or gravitational forces. „If the centripetal force [of the peripheral planet] is decreased, then the rotat-

⁶¹ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 10, 23, 45.

⁶² Marx, „Kapital. Kritik der politischen Ökonomie. Erster Band. Hamburg 1872“, in *MEGA*², vol. II/6 (Berlin: Dietz, 1987), 272-73. Also see Weston, „Marx on the Dialectics of Elliptical Motion“, 30.

⁶³ Engels, „Anti-Dühring“, in *MEGA*², vol. I/27, 439.

⁶⁴ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 84.

⁶⁵ H. Helmholtz, *Ueber die Wechselwirkung der Naturkräfte und die darauf bezüglichen neuesten Ermittlungen der Physik. Ein populär-wissenschaftlicher Vortrag gehalten am 7. Februar 1854* (Königsberg: Gräfe, 1854), 38-9.

⁶⁶ J. R. Mayer, *Die Mechanik der Wärme in gesammelten Schriften* (Stuttgart: Cotta, 1874), 171.

ing body approaches slowly to the central body“.⁶⁷ In Thomson and Tait’s *Treatise on Natural Philosophy* we read that the „effect of a continued tangential force ... is to gradually increase the distance from the central body, and to cause as much again as its own amount of work to be done against the attraction of the central mass, by the kinetic energy of motion lost“.⁶⁸

Engels did not deny the postulate that earth would eventually hit the sun, but he was highly skeptical of the theological extrapolations that displayed in the backdrop of these cosmological theories.⁶⁹ By using the analogy of the elliptical apocalypse and the end of capitalist mode of production, Engels, like Marx, seems to have initiated a strategy to play the Christian eschatological cosmology off against the bourgeois view of harmonious free market society.

However, there is also a few slight differences between Marx and Engels in the ellipse case. What Marx calls a contradiction is between two opposite tendencies of the orbit, to fly away from or fall into the sun, while Engels puts the same contradiction between „attraction“ of the sun and the „tangential force“ of the orbit, although he raises his suspicions about the force character of the inertial motion.⁷⁰ For Marx, the elliptical motion results from the contradiction of opposed tendencies of the orbit; this contradiction is „actualized just as much as it is solved“.⁷¹ For Engels, the annular bodies of the solar system first „separate“ because the „rotational motion comes into contradiction with itself“, and then as soon as „the separation is complete“, „the motion is again a unity“.⁷² All in all, for Marx, a contradiction results from two opposite predicates (flying away from and falling into the sun) of *one* subject (orbit). For Engels, at least in the aforementioned ellipse passage, the contradiction results from two opposite predicates (gravitation and inertial tendency) of *two* subjects (sun and orbit). This is crucial for our understanding of how the term ‘contradiction’ is coined by Marx and Engels, respectively.

What is more than a few terminological differences between Marx and Engels is that the latter presupposes (at least) three contradictions in solar system, not one. Beside the elliptical contradiction, Engels envisions the sun as a contradictory unity of attraction and repulsion, which leads him to the contra-

⁶⁷ J. H. Mädler, *Der Wunderbau des Weltalls oder Populäre Astronomie* (Berlin: Carl Heymann, 1861), 165.

⁶⁸ William Thomson and Peter Guthrie Tait, *Treatise on Natural Philosophy. Vol. I* (Oxford: Clarendon, 1872), 192.

⁶⁹ Newton, Helmholtz, Thomson and Tait were leading figures in promoting religious views by using physics and astronomy.

⁷⁰ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 45, 23.

⁷¹ Marx, „Kapital“, in *MEGA*², vol. II/5, 65.

⁷² Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 45.

diction of reception and dispersal of energy. In the following section I deal with these second and third contradictions and their relation to the first one. This will help us to clarify some issues concerning Engels's definition of dialectics of nature, and its implications for a Marxist ecology.

The Second and Third Contradictions

Based on Laplace's theory of the formation of celestial mechanics, Engels asserts that, historically, it was heat, not gravitation, which was the predominant form of motion of matter in our galaxy. The progressive cooling of nebular bodies gave birth to the interplay of the physical forms of motion which become transformed into electricity, magnetism and mechanical motion. The present „conflict of heat with gravity“ of the sun is an ultimate product of this historical process.⁷³ The sun is not only a central body attracting orbits rotating around it, but it also produces repulsion via heat.⁷⁴ Indeed, the „existential process of a solar system presents itself as an interplay of attraction and repulsion, in which attraction gradually more and more gets the upper hand owing to repulsion being radiated into space in the form of heat“. This repulsive form of motion is nothing but „energy“. ⁷⁵ The sun is subject to generation of gravitational attraction, on the one side, and to heat radiation toward the rotating orbits, on the other. This unity of „attraction *and* repulsion“ emerges from a dialectical interplay of different forms of motion with opposite directions.⁷⁶ This is Engels's 'second contradiction'.

The 'third contradiction', which is derived from the second one, is based on the universal principles of transformation of heat, and the reception and dispersal of energy. „The motion cannot be created but only transformed“. ⁷⁷ The interrelation of central body and its orbit as an open system proves it.

The time when the planet acquires a firm shell and accumulations of water on its surface coincides with that from when on its intrinsic heat diminishes more and more compared with the heat emitted to it from the central body. Its atmosphere becomes the arena of meteorological phenomena ... [and] its sur-

⁷³ Ibid., 80-1. The correlation between mechanical force and solar radiation was a widely circulated and hotly debated issue in the weekly *Nature*, a magazine which Engels was regularly following. See anonymous, „On Attraction and Repulsion Resulting from Radiation“, *Nature*, vol. 11 (April 22, 1875): 494-95; Osborne Reynolds, „The Attraction and Repulsion caused by the Radiation of Heat“, *Nature*, vol. 12 (May 6, 1875): 6; William Crookes, „Attraction and Repulsion caused by Radiation“, *Nature*, vol. 12 (June 17, 1875): 125.

⁷⁴ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 142.

⁷⁵ Ibid., 191.

⁷⁶ Ibid., 116.

⁷⁷ Engels, „Anti-Dühring“, in *MEGA*², vol. I/27, 264.

face becomes the arena of geological changes in which the deposits resulting from atmospheric precipitation become of ever greater importance compared with the slowly decreasing external effects of the hot fluid interior.⁷⁸

Thus, later it shall be a task of natural sciences to elaborate more precisely how the energy radiated by the sun transforms into different forms of motion.⁷⁹ But what needs to be acknowledged in the first place, Engels implies, is that the transformative and entropic behavior of energy embodies a contradiction in form of its dispersal and reception.⁸⁰

There is also a controversy involved in this third contradiction. When referring to the apocalyptic end of elliptical orbits, Engels also assumes that „the declining warmth of the sun will no longer suffice to melt the ice“ and „the last trace of organic life will vanish“. The ultimate consequence of this process will be that „the earth, an extinct frozen globe“ will circle in an „ever narrower orbit around the equally extinct sun, and at last fall into it“. ⁸¹ This is controversial not only because its accuracy was, and still is, highly questionable, but also because Engels himself denied it in a 1869 letter to Marx. He called the heat death hypothesis a „very absurd theory“, and said that it is „impossible to imagine anything more stupid“. ⁸² In his later writings, Engels seems to have changed his opinion, for he was actually objecting to the extrapolations of the heat death theory to promote religion, and attacking the theory of *absolute* death of energy in the universe, a theory which contradicts the transformative character of matter-energy. ⁸³ Put the controversy aside, what is clear is that Engels conceived of the relative equilibrium of cosmological order, including the planetary motion, as a material precondition of life on earth. If the planetary temperature „so far equalized that over a considerable portion of the surface at least it no longer exceeds the limits within which pro-

⁷⁸ Frederick Engels, „Dialectics of Nature“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 25 (Moscow: Progress Publishers, 1987), 329.

⁷⁹ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 86.

⁸⁰ *Ibid.*, 189. Engels does not use the term „contradiction“ in the entropy case, but translates it into his dialectical terminology as the interconnectedness of „motion of attraction“ and „motion of repulsion“. Here I reinforce his argument that transformative and entropic behavior of energy embodies a contradiction, which fully conforms to the first and second laws of thermodynamics.

⁸¹ *Ibid.*, 83-4.

⁸² Friedrich Engels, „Engels an Marx, 21. März [18]69“, in *MEW*, vol. 32 (Berlin: Dietz, 1974), 286-87.

⁸³ For an elaborated view on the heat death controversy, see Foster and Burkett, *Marx and the Earth. An Anti-Critique*, Chapter 4.

tein is capable of life, then, if other chemical pre-conditions are favorable, living protoplasm is formed“.⁸⁴

Does Planetary Motion Matter?

Given the voluminous material on this subject, it is curious that Marx and Engels's concept of planetary motion did not enjoy much scholarly attention. It is hardly mentioned by Marxian philosophers,⁸⁵ and completely ignored by ecologists.⁸⁶ Is this because planetary motion is potentially irrelevant to Marxist dialectics and ecology?

One might argue that it actually is irrelevant because even if the sun has a potential impact on climate change and ecological crisis, this would become obvious in the extremely long run only. If nothing significant immediately follows from the planetary motion for human action and policy in the near future, then why take it seriously?⁸⁷

Some scholars claim indeed that the „Marxian economics and economic history was based on social and economic analysis alone“.⁸⁸ Natural scientific subjects such as thermodynamics or astrophysics are not „helpful at all in explaining the shifting history of human social organization“.⁸⁹ Some others charge Marx and Engels with insufficient consideration of the „limits that na-

⁸⁴ Frederick Engels, „Dialectics of Nature“, in Karl Marx and Frederick Engels, *Collected Works*, vol. 25, 329; translation modified.

⁸⁵ Andreas Arndt, *Karl Marx. Versuch über den Zusammenhang seiner Theorie* (Berlin: Akademie, 2012), 239, 249; Hyman R. Cohen, „Countering the Revisionism of Marxist-Leninist Philosophy“, in Alan R. Burger (ed.), *Marxism, Science, and the Movement of History* (Amsterdam: Grüner, 1980), 111, 118; Hubert Horstmann, „Der dialektische Widerspruch im universellen Zusammenhang“, in Gerhard Bartsch (ed.), *Der Dialektische Widerspruch* (Berlin: Akademie, 1986), 69; Chikatsugu Iwasaki, „Die Grundgesetze und die Kategorien der Dialektik“, in Siegfried Bönisch et al. (ed.), *Marxistische Dialektik in Japan* (Berlin: Dietz, 1987), 64-5; M. Mark Mussachia, „On Contradiction in Dialectical Materialism“, *Science & Society*, vol. 41, no. 3 (Fall, 1977): 263, 275; John Stachel, *The Concept of Polar Opposition in Marx's Capital*, available at: <http://actuelmarx.u-paris10.fr/cm6/com/MI6_Etmarx_Stachel.doc>, accessed December 2015. Certainly, Weston's study is an exception.

⁸⁶ Foster and Burkett quote the passage on elliptical apocalypse in *Dialectics of Nature*, but do not take the elliptical collapse into consideration. See Foster and Burkett, *Marx and the Earth. An Anti-Critique*, 180.

⁸⁷ For a similar account, see Herman E. Daly, „The Economic Growth Debate: What Some Economists Have Learned But Many Have Not“, *Journal of Environmental Economics and Management*, 14 (1987): 325.

⁸⁸ J. Martinez-Alier, „Political Ecology, Distributional Conflicts, and Economic Incommensurability“, *New Left Review*, I/211 (1995): 72.

⁸⁹ David Harvey, „The Nature of Environment and the Dialectics of Social and Environmental Change“, *Socialist Register*, 29 (1993): 39.

ture imposes on the development of humanity and society”.⁹⁰ This is most obvious in a few circles that fall prey to a „great temptation to leave [ecological] matters there and to interpret the forecast of a great ecological crisis as a manoeuvre intended to divert people from acute political controversy. There are even said to be parts of the left which consider it a luxury to trouble themselves with problems of the future”.⁹¹ This alleged „bad blood between Marxists and ecologists”⁹² is contested by a number of Marxian ecologists that Marx and Engels’s historical materialism did actually embody a „powerful ecological critique”. But their ecology „fell victim to the great split that opened in the 1930s between Western Marxism and Soviet Marxism”. The „schism within Marxism centered on the applicability of dialectics to the natural realm, and on the question of where Marx and Engels themselves stood on this issue”.⁹³

The gist of the Marxian ecology is about the „use of socially developed productive forces for a sustainable, healthy co-evolution of human and extra-human nature“, building an „effective social management of natural conditions“ and an ecologically sound system of social production „regulating the use of natural conditions“. ⁹⁴ The issue at stake is „how increasing scarcities of resources and environmental amenities in general lead to enhanced ecological costs, thereby squeezing profit margins“. ⁹⁵ Now all this involves scientific knowledge of metabolic exchange and rift between nature and society. But to what extent? To the extent of cosmology? Vladimir I. Vernadskii and Aleksandr I. Oparin, two prominent figures of Soviet ecology, answers this question affirmatively. They believe that all ecological knowledge necessarily involves cosmology, an aspect which is barely recognized by contemporary Marxian ecologists. ⁹⁶

⁹⁰ Reiner Grundmann, „The Ecological Challenge to Marxism“, *New Left Review*, I/187 (1991): 104.

⁹¹ Hans Magnus Enzensberger, „A Critique of Political Ecology“, *New Left Review*, I/84 (1974): 90.

⁹² Ted Benton, „Marxism and Natural Limits: An Ecological Critique and Reconstruction“, *New Left Review*, I/178 (1989): 55.

⁹³ John Bellamy Foster, „Marxism and Ecology. Common Fonts of a Great Transition“, *Monthly Review* 67, no. 7 (December 2015): 4.

⁹⁴ Paul Burkett, *Marx and Nature. A Red and Green Perspective* (New York: St. Martin’s Press, 1999), 223-24, 227.

⁹⁵ John Bellamy Foster, „The Great Capitalist Climacteric: Marxism and „System Change Not Climate Change““, *Monthly Review* 67, no. 6 (November 2015): 9.

⁹⁶ Vladimir I. Vernadsky, *The Biosphere* (New York: Copernicus, 1998), 43; A. I. Oparin, *The Origin of Life on the Earth* (New York: Academic Press, 1957), 48-50; George S. Levit, *Biogeochemistry – Biosphere – Noosphere. The Growth of the Theoretical System of Vladimir Ivanovich Verdansky* (Berlin: BWB, 2001), 72-3. Foster’s recent study on Soviet ecology overlooks Vernadskii and Oparin’s contributions to the cosmological

However, the reason of my emphasis on cosmology is not simply that it extends our knowledge of planetary ecology, but because it brings a few challenges to the core ideas of Marxian and non-Marxian ecologies. The major postulate of any critical ecology is that ecological crises result from social disruptions of ecosystems. Accordingly, it is the industrial societies that produce ecological contradictions which would eventually lead to their own collapse.⁹⁷ I shall argue that this is not entirely true. There is a variety of cosmological factors that need to be taken into consideration, as well. For example, a 2010 study on the celestial origins of the climate change underlines that „the planets with their movement cause the entire solar system to vibrate with a set of frequencies that are closely related to the orbital periods of the planets. The wobbling of the Sun around the center of mass of the solar system is just the clearest manifestation of these solar system vibrations“. It is stressed that the climate change is „more complex than just a response to added CO₂ and a few other anthropogenic GHGs [greenhouse gases]“. Within a 60-year cycle in the climate system, „at least 60% of the observed warming ... has been naturally induced. This leaves less than 40% of the observed warming to human emissions“.⁹⁸

This account goes back to the so-called Milankovich approach⁹⁹ that explains the climate due the „varying insolation of the Earth by changes in the Earth’s orbital parameters, such as the distance to the Sun, the axial inclination, and the precessional motion“. Some particular level of shearing motions in the solar plasma can cause storage and deformation of magnetic fields of the orbits, with possible consequences of earth’s heliosphere. This is closely linked to an alternative understanding indicating that the climate change results from solar variability or „varying emissions of radiation and of magnetized plasma“.¹⁰⁰ Furthermore, this approach points at the connections between rotational angular momentum of the sun, expansion of orbital radius and planetary ecology. Angular momentum is a measure for the tendency of an orbital body to keep its inertial motion. According to an extended version of the Milankovich approach, the rotational angular momentum of the sun is

factor in planetary ecology. See John Bellamy Foster, „Late Soviet Ecology and the Planetary Crisis“, *Monthly Review* 67, no. 2 (2015): 1-20.

⁹⁷ Enzensberger, „A Critique of Political Ecology“, 4; Grundmann, „The Ecological Challenge to Marxism“, 109.

⁹⁸ Nicola Scafetta, „Empirical evidence for a celestial origin of the climate oscillations“, *Journal of Atmospheric and Solar-Terrestrial Physics* 72 (2010): 967.

⁹⁹ Milutin Milanković, *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitproblem* (Belgrad: Königlich-Serbische Akademie, 1941).

¹⁰⁰ Corlenis De Jager and Gerard J. M. Versteegh, „Do Planetary Motions Drive Solar Variability“, *Solar Physics*, 229 (2005): 175-76.

currently decreasing, and this increases the orbital radius of earth. At the same time, the rotation of earth is gradually slowing down due to the tidal forces between the moon and earth.¹⁰¹

Back to Marx and Engels

I have to admit that the challenge of astronomy to ecology might be misleading in a way. What is potentially contested by astronomy in ecology is not that the latter simply refuses the macro-dynamics of the cosmos which jointly govern the planetary ecosystem. The major problem is that the self-proclaimed Marxist ecologists overlook the cosmology aspect in Marx and Engels themselves. In this sense I believe there is a serious flaw when it comes to interpreting Marx and Engels from an ecological standpoint. Since there is evidence that Marx and Engels took the possible impacts of celestial mechanics on planetary ecology seriously, we ought to ask what discipline or ideology is supposed to take this cosmology factor into account, if not a Marxist ecology? Two further references of Marx and Engels, Mayer and Croll, might be helpful in this regard.

In a passage in *Celestial Dynamics* Mayer investigates the emergence of tidal waves on earth. He stresses that tidal waves are caused by the „attraction exercised by the sun and the moon on the moveable parts of the earth’s surface, and by the axial rotation of our globe“. In return, tides cause „a diminution of the velocity of the rotation of the earth“. The moved waters experience a resistance, „in consequence of which the flow of the tidal wave is delayed, and high water occurs in the open sea on the average about 2 hours after the transit of the moon through the meridian of the place“. ¹⁰² Winds in polar currents or motion of cold and warm waters are also involved in this interaction.

The other reference is James Croll,¹⁰³ a nineteenth-century Scottish climatologist and precursor of Milanković, who famously asserted that the ice ages were originally driven by changes of solar radiation which caused instabilities in the orbit and spin axis of the earth. Correspondingly, it was earth’s orbital

¹⁰¹ Takaho Miura et al., „Secular increase of the Astronomical Unit: a possible explanation in terms of the total angular momentum conservation law“, *Astronomy & Astrophysics*, May 19, 2009: 2-3.

¹⁰² J. R. Mayer, „On Celestial Dynamics“, in *A Series of Expositions, by Prof. Grove, Prof. Helmholtz, Dr. Mayer, Dr. Faraday, Prof. Liebig and Dr. Carpenter* (New York: Appleton, 1865), 291-92. The German original of this text can be found in Mayer, *Die Mechanik der Wärme*, Chapter 5.

¹⁰³ Engels, „Dialektik der Natur“, in *MEGA*², vol. I/26, 59. Engels refers here to a book review of Croll’s *Climate and Time*. To my knowledge, there is no supporting evidence that Engels read Croll’s work.

eccentricity and precession that cause a variation of solar irradiance and heat distribution on earth.¹⁰⁴

There are two causes affecting the position of the earth in relation to the sun, which must, to a very large extent, influence the earth's climate; viz., the precession of the equinoxes and the change in the excentricity of the earth's orbit.¹⁰⁵

Croll repeats the very solar-orbit interrelation in his opus magnum, *Climate and Time*: when the eccentricity of the earth's orbit reaches a high value, a combination of physical circumstances tends to lower the temperature of the hemisphere which has its winter solstice in aphelion, and to raise the temperature of the opposite hemisphere, whose winter solstice will, of course, be in perihelion.¹⁰⁶

There is evidence that Marx was familiar with Croll's theory, and affirmed it on different occasions. In Marx's 1878 excerpts on geology, mineralogy and agricultural chemistry, Croll's name is mentioned several times.¹⁰⁷ For the present essay the following two passages from Marx's excerpts are worth noting: Such climatic changes largely due (*Croll, Phil. Mag.* 1864 a. his papers on climate in the same journal for succeeding years) through the varying position of the earth toward the sun, owing to the eccentricity of its orbit; can be partially influenced too, although not in the same hierarchy, by changes in the distribution of sea and land. Ocean currents the great distributors of temperature a. what it tends to materially modify must exercise a great influence on climate.¹⁰⁸

Certainly, *cosmic circumstances* can affect relative levels of land and water. „In succession of attraction caused by the accumulation of great ice masses at the pole, the *general level of the ocean could be raised in polar and diminished in equatorial latitudes*. The same produced by *diminution of centrifugal force* owing to the *retardation of the earth's rotation* caused by the *tidal wave*“ (*Croll*).¹⁰⁹

¹⁰⁴ Richard A. Muller and Gordon J. MacDonald, „Glacial Cycles and Astronomical Forcing“, *Science* 277 (1997): 215.

¹⁰⁵ James Croll, „On the Physical Cause of the Change of Climate durin Geological Epochs“, *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, vol. 28 (1864): 129.

¹⁰⁶ James Croll, *Climate and Time in their Geological Relations. A Theory of Secular Changes of the Earth's Climate* (New York: Appleton, 1875), 97.

¹⁰⁷ Karl Marx, „Exzerpte und Notizen zur Geologie, Mineralogie und Agrikulturchemie. März bis September 1878“ in *MEGA IV/26* (Berlin: Akademie, 2011), 146, 190, 196, 236, 237.

¹⁰⁸ *Ibid.*, 237-38. The passage in original is bilingual (German and English). Grammatical irregularities originate from Marx.

¹⁰⁹ *Ibid.*, 146.

Croll might be a forgotten figure today, but he was extremely influential in the British scientific circles in the nineteenth century.¹¹⁰ He was a correspondent of, and exchanged ideas with, Charles Darwin, Charles Lyell, John Tyndall, John Herschel and many others. In a 1868 letter by Darwin to Croll we read the following:

I hope that you will allow me to thank you for sending me your papers in the *Philosophical Magazine*. I have never, I think, in my life been so deeply interested by any geological discussion. I now first begin to see what a million means, and I feel quite ashamed of myself at the silly way in which I have spoken of millions of years.¹¹¹

Two months later, Darwin consulted Croll again, for the former was preparing a new edition of his *Origin of Species* and he was „anxious to say a few words on this subject on your authority“.¹¹² Darwin also tried to persuade Lyell of the importance of Croll’s ideas. Although Lyell was „inclined to profit by Croll’s maximum excentricity for the glacial period“ he considered it „quite subordinate to geographical causes or the relative position of land & sea & the abnormal excess of land in polar regions“.¹¹³ In any case, when revising his *Principles of Geology*, Lyell decided to respond to Croll’s theory and to „take care in the new edition of my *Principles* fully to cite your valuable paper“.¹¹⁴ This new edition was the tenth edition of *Principles* which Marx read when he focused on geological questions.

Some Concluding Remarks

Many of Marx’s and Engels’s voluminous studies on cosmology and its impacts on planetary ecology are unfinished and consist of sketchy notes, extracts or short references. It is not certain whether Marx could have said more on elliptical motion if he had studied the cosmic factors in ecosystems to a greater extent. And it is also an open question whether Engels would have

¹¹⁰ For a detailed study on Croll’s influence see James Rodger Fleming, „James Croll in Context: The Encounter between Climate Dynamics and Geology in the Second Half of the Nineteenth Century“, *History of Meteorology* 3 (2006): 43-54.

¹¹¹ Charles Darwin to John Croll, „19th September 1868“, in James Campbell Irons, *Autobiographical Sketch of James Croll with Memoir of his Life and Work* (London: Edward Stanford, 1896), 200.

¹¹² Charles Darwin to John Croll, „24th November 1868“, in *ibid.*, 202.

¹¹³ Charles Lyell to Charles Darwin, „March 1st/[18]66“, in Frederick Burkhardt et al. (ed.), *The Correspondence of Charles Darwin*, vol. 14, 1866 (Cambridge: Cambridge University Press, 2005), 89.

¹¹⁴ Charles Lyell to James Croll, „13th February 1865“, in Irons, *Autobiographical Sketch of James Croll with Memoir of his Life and Work*, 117.

revised his remarks on contradictions of planetary motion in *Dialectics of Nature* if he had had more time after Marx's death. What is certain is that both had profound meditations on the dialectical interplay of cosmology and ecology, and that these meditations have a deep inquisitive quality. Those who are used to read Marx and Engels as instructors and demonstrators shall be disappointed, for the latter were rather investigators and explorers when it comes to natural sciences.

I certainly display little sympathy for a reading of 'Marx against Engels' as well as of 'Marxism vs. ecology'. Doctrinal framing of Engels's natural dialectics is no better than bracketing Marx and Engels's ecology from their political and scientific legacies off. Thus, I suggest not only resisting any dogmatic narrative of Marx and Engels but also extending our interpretive framework of Marxist dialectics and ecology toward cosmology.

I have tried to show in the ellipse case that the tables can be turned for any dialectician who believes that there is nothing more than a method of investigation and depiction in Marx's dialectics. The term 'dialectics' also means structure of relations and universal interplay of contradictions in nature and society. As regards the Marxist ecology, Marx and Engels have written on ecology more than most of the ecologists assume they did. What Marx and Engels wrote on ecology to what extent is a matter of textual evidence and this corresponds, in my opinion, to the 'easy problem' of dialectics. The 'hard problem', on the other hand, is a subject that requires no immediate solution but a recognition of all possible aspects of what we call today 'ecology'. Planetary motion is no exception in this regard.

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