J D Bernal: philosophy, politics and the science of science

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Abstract: This paper is an examination of the philosophical and political legacy of John Desmond Bernal. It addresses the evidence of an emerging consensus on Bernal based on the recent biography of Bernal by Andrew Brown and the reviews it has received. It takes issue with this view of Bernal, which tends to be admiring of his scientific contribution, bemused by his sexuality, condescending to his philosophy and hostile to his politics. This article is a critical defence of his philosophical and political position.

Why is JD Bernal being honoured in Ireland today?

It is because he emerged from this part of the world to become a scientist of world renown. It is also because he pioneered the discipline variously called STS (science technology society), social studies of science, science studies, the science of science. Although he reached the heights of established academe, he engaged in a radical critique of its cherished assumptions and structures of power. He was a leading light in a movement for the social responsibility of science. He was an activist in many causes. He brought science to bear in war and then turned his energies to peace. He led a complicated life, living an unconventional domestic life, sitting on hundreds of committees and playing a leading role in many scientific and political organizations.

His legacy is complex. All the more so because he was marxist in philosophy, communist in politics, polyamorous in sexuality. On these matters, many have ambivalences about him, even part ways with him. Nevertheless, I want to make a case for these more difficult dimensions of his legacy, focusing on his philosophy and his politics. Moreover, I want to argue that these were central to who he was and the contribution that he made and not somehow peripheral.

Bernal is the subject of renewed attention just now, not least because of the publication of Andrew Brown's recent biography of Bernal [1], but for a number of other reasons as well. There were events this year (2006) at Princeton University and at the Science Museum in London marking the 75th anniversary of the 1931 international history of science congress where Soviet and British marxists came into such consequential interaction with each other. This was a pivotal event in the intellectual development of Bernal.

At the congress, contrasting world views were in collision. This event received much publicity in Britain at the time. The book *Science at the Crossroads* [2], containing the Soviet papers from the congress, has been translated into many languages and has had enduring impact over the world and over decades. Bernal was strongly influenced by the Soviet thinkers as well as influential in extending this influence. When Bernal encountered Bukharin, Hessen and their colleagues in 1931, he was struck by the unity, philosophical integrality, and social purpose of the Soviet delegation in contrast with their British colleagues with their undisciplined philosophies and remoteness from social considerations.

Twenty congresses later, there was also much discussion of Bernal, his contemporaries and their legacy at the 2005 international history of science congress in Beijing.

There are also whatever forces have brought the legacy of Bernal to the attention of the Institute of Physics in Ireland and organised the Limerick event on Bernal and are considering setting up a Bernal Institute.

There has also been much attention to Bernal, including several biographies [3], between the years of his initial impact in the 1920s and today.

There are various views of Bernal in play. Decades after his death, he still stirs controversy, although perhaps not quite enough. There is, I believe, a consensus about Bernal emerging and I want to contest it. I particularly want to address the attitude to Bernal pervading the Brown biography and the reviews of it that I have seen in recent months.

The Brown biography of Bernal is an extremely valuable work of scholarship. I learned much that I did not know about Bernal and much else from reading it. However, I do not concur with his attitude to Bernal. Brown is admiring of Bernal's science and his war effort, matter of fact about his sex life and condescending about his philosophy and his politics. Most reviewers that I have read take this stance as well. The book has been widely praised, not only for its scholarship, but for its overall judgement of Bernal.

What is being said about the philosophy of Bernal? Very little actually, either by Brown, despite a book of 562 pages, or by reviewers. It sometimes seems as if the very mention of dialectical materialism somehow makes the case that it is self-evidently ridiculous. Brown quotes Michael Oakeshott, conservative philosopher, as accusing Bernal of a "primitive passion for analogy [that was] almost unchecked and the result of a mystical and esoteric philosophy which can be paralleled, perhaps, only in the writings of the alchemist". [4] The *TLS* reviewer followed a repetition of the Oakeshott quote with the pronouncement that "the real spells were those that scientists cast over themselves". [5]

The reviewer in *Nature* wrote: "In the 1930s, Bernal became committed to marxism. How a man with such a marvellous analytical mind could come to terms with dialectical materialism is still a subject of discussion — it seems to have been an act of faith, a substitute for catholicism." [6] This cliché about catholics who become communists is quite familiar to me and it is extemely objectionable. It inevitably comes from those who have been neither catholics nor communists nor ever studied either seriously. Let me admit that I take this quite personally as a catholic who became a communist, although for most of my life I have been unable to live within the confines of either the Catholic Church or the Communist Party. It is also why I believe that I understand this about Bernal as well as Caudwell [7] and others who have made this transition. It is something much deeper and much different from what this glib jibe implies.

Catholicism instills a taste for totality: a comprehensive world view and a radical moral commitment in relation to it. This integrality often survives belief in God and all other articles of the faith of our fathers (and our mothers). What often lies in between one world view and another is a serious philosophical quest in which many alternatives are considered. Those who judge it must earn their right to such judgement with a philosophical argument worthy of the intellectual process they are judging. I do not believe that Brown or his admiring reviewers have done this.

Bernal came to marxism seriously and intelligently. He found in its philosophical framework a structure in which he could live, think, create, pursue science, act politically and develop further. It opened him radically to the world, rather than closing him down or constricting him, as critics imply. Andrew Rothstein once described the effect of becoming a marxist on JBS Haldane, who was already a mature scientist when he came to marxism, saying it had an 'open sesame' effect as he ranged through the whole body of knowledge that he had already acquired and then pushed on further. [8] I believe that it was the same for JD Bernal.

What is the philosophical position of marxism that is held in such scorn by these commentators? [9] It is materialist in the sense that of explaining the natural world in terms of natural forces and not supernatural powers (which, by the way, is as radical a break as it is possible to make from catholicism). It is dialectical in the sense of being evolutionary, processive, developmental. It is radically contextual and relational in the sense of seeing everything that exists within the web of forces

in which it is embedded. It is empiricist without being positivist or reductionist. It is rationalist without being idealist. It is coherent and comprehensive while being empirically grounded. It needs constantly to be revised in light of the most advanced science, the most up-to-date knowledge, of its time.

It is a way of seeing the world in terms of a complex pattern of interconnecting processes where others see only disconnected and static particulars. It reveals the way in which economic structures, political institutions, legal codes, moral norms, cultural trends, scientific theories, philosophical perspectives, even common sense, are all products of a pattern of historical development shaped by a mode of production.

Bernal considered the Marxist philosophy of dialectical materialism to be the most suitable philosophy for science. His philosophy of science was in the tradition of Friedrich Engels. The important thing about Engels's concept of nature, Bernal argued, was that he saw it as a whole and as a historical process. In Bernal's opinion, if this philosophy of science had been more widely known in the scientific world, theories underlying relativity, quantum physics, biochemistry and genetics might have been discovered sooner and would be free from the idealistic confusions under which they were suffering.

For Bernal, dialectical materialism was the most powerful intellectual current of the time. It provided the basis, not only for a revolutionary social movement, but also for the enhancement of science. It was a philosophy derived from science that brought order and perspective to science and illuminated the onward path of science. It was no substitute for science. It was no royal road to knowledge. Induction and proof remained what they were and the hard work still had to be done. It was not a dogma imposed on the findings of science from without, but a method of co-ordinating the experimental results of science and of pointing the way to new experiments, a method that had been developed in and through the development of science itself. Its role was to clarify and to unify the different branches of science in relation to one another and to other human activities and to suggest directions of thought that were likely to yield further results in the future**.**

He saw dialectical materialism as a science of the sciences, a way of integrating the sciences, a way of contextualising science in deep socio-historical perspective. He saw marxist philosophy of science as a means of overcoming overspecialisation and achieving the unity of science. [10]

A resolute monist, Bernal saw the unity of science as grounded in the unity of the universe itself. He affirmed the unity of the universe, not in a hollowly reductionist way, but in a way that recognised the intricacy and complexity of matter that had evolved in such a way that new qualities emerged at higher levels of organisation. The origin of the new, however, had to be seen against the ongoing process, so as to avoid the two extremes in which the immediate apprehension of quality was made the basis of mystical speculation on the one hand or mechanically denied altogether on the other.

Bernal saw science as a social activity, integrally tied to the whole spectrum of other social activities: economic, cultural, philosophical and political. His sense of history was sweeping and every particular was placed within an epochal grand narrative. [11]

Bernal's book *The Social Function of Science* of 1939 quickly came to be regarded as a classic in this field. [12] Based on a detailed analysis of science, both under capitalism and under socialism, he argued that science could achieve its full potential only under socialism. According to Bernal, science was outgrowing capitalism, which had begun to generate a distrust of science that in its most extreme form turned into rebellion against scientific rationality itself. The cause of science was, for Bernal, inextricably intertwined with the cause of socialism. He saw science as holding the key to the future and the forces of socialism alone as gathering to turn it. Later he developed this historical analysis further in his multi-volume work *Science in History.* [13]

He was extremely critical of alternative philosophies of science, both to positivism and to many from of anti-postivism. He was unsympathetic to tendencies to equate science with positivism, but even more so of tendencies that were so preoccupied with the critique of positivism as to undermine science. He thought of irrationalist and intuitionist currents as the backwaters and dead ends of human knowledge. He objected most to scientists, such as Jeans and Eddington, who were bringing irrationality into the structure of science itself and making what science did not know, rather

than what it did know, the basis for affirmations about the nature of the universe. These trends have multiplied since his time. He would be polemicising against both neopositivism and postmodernism if he were alive today for the same reasons.

Bernal was a leading force in a new movement for social responsibility in science that took a number of organisational forms, such as the Association of Scientific Workers and the Division for Social and International Relations of Science within the British Association. It had impact as well as opposition. The oppositional manifesto was John Baker's 'Counterblast to Bernalism' and its organisational form was the Society for Freedom in Science, which devoted itself to the defense of 'pure science' and the absence of any form of social control of science. Bernal believed that all science was inextricably enmeshed in social forces.

Bernal functioned in terms of *Weltanschauung.* Science, philosophy and politics were all tightly bound together in his highly integrated mind. He took issue with those who believed that science could get along quite well without philosophy or politics and refused to see the unexamined philosophical and political assumptions masked by this stance.

Anyone who claims to understand Bernal without understanding this integrality, particularly the relation of his philosophy and politics to his science, does not understand him.

The reviewer of Brown's biography in *Science* observes: "Although agreeing that Bernal's science and communism were two sides of the same coin, the author continues to see the political side as 'counterfeit' and in the end fails to make Bernal's position understandable." [14] I agree.

To understand Bernal is to understand the interconnections. Martin Bernal, who has turned out to be as controversial as his father and who also comes into my history of ideas lectures at DCU, dedicated his much acclaimed, much denounced book *Black Athena* to his father "who taught me that things fit together, interestingly". [15] As Alan Mackay has put it: "His picture of the world was a unified one and he fitted new facts into a changing whole." [16]

What is there in his politics and his philosophy to bring forth the scorn of contemporary commentators? What more appropriate philosophy is there for a natural scientist or anyone else? positivism? postmodernism? theism? As for politics, what sheds more light on the world that we inhabit? neoliberalism? neoconservatism? In the name of what are these commentators so superior in passing such judgments? What philosophical, what political, positions do they embrace? They do not say.

There are other positions, even in ivy league academe. Interestingly Loren Graham of MIT, who has spent his whole professional life studying Soviet and post-Soviet science and philosophy of science has said of dialectical materialism: "This philosophy of science is actually quite a sensible one and corresponds to the implicit views of many working scientists all over the world" [17] Graham, who, incidentally, is not a marxist, goes on to show that this philosophy has had a lasting impact on Russian scientists, even after the demise of the Soviet state. [18]

About the Soviet Union: this is an area where Bernal has come in for much criticism. Yes, I concede that he should have been more critical of the USSR. However, I think that it takes a lot more than repeating dominant media clichés or even reading books by Pipes or Conquest to constitute a basis for judging his position. [19]

The USSR was a vast transformation in the history of the world. It was an attempt to expropriate the expropriators of the world, to bring enlightenment and equality where there was darkness and despair, to honour labour and to seize power from those who parasited upon labour, to create a society according to the principle "from each according to their ability, to each according to their needs". It brought about a massive shift in the balance of power in the world. It was a heroic undertaking. It was full of brilliant and honest thought and brave and generous activity.

Bernal was part of this, as were his contemporaries Cornford, Caudwell, Guest, who bled to death on the fields of Spain, such was the intensity of their commitment to this vision. To understand Bernal it is essential to understand, even if it requires an immense imaginative leap, what it meant to be a communist, what it meant to have vision, a vision that was under attack, what it meant to take sides, what it meant to put your life on the line for the lives of others.

To reduce the whole communist movement, this movement of Bernal, Haldane, Caudwell, Guest, Gramsci, Bukharin, and many others whose names have faded from social memory, to Stalin and Lysenko is grotesquely unfair. To reduce this whole brave and brilliant historical experiment in socialism, to its failures, its tragedies, its betrayals might be the orthodoxy of our time, but it is not the truth, not the whole truth.

The marxist approach to science was seen by Bernal as still being in the process of being formulated. He thought that Marx, Engels, Lenin and Bukharin had only sketched the outlines of it and that it was being further developed particularly in the Soviet Union in a lively and sometimes violent process. He was aware of the main outlines of the Soviet debates and saw Soviet science as finding its philosophy in the very course of its revolutionary development. It was, he remarked, complicated at times by the fact that the older scientists were often hostile to new philosophical ideas, while the younger ones, who were most receptive, often lacked sufficient scientific knowledge. He knew of the clash between Vavilov and Lysenko, but did not seem to realise the gravity of what was taking place in this sphere, describing it as a difference in emphasis between hereditary and environmental factors, without articulating how these intellectual debates had become caught up in a complicated and deadly struggle for power.

Bernal himself was firmly committed to the science of genetics and was conducting experiments aimed at discerning the molecular structure of the gene. He was, on the whole, extraordinarily impressed by Soviet science and philosophy of science, at times more so than the situation warranted, always giving the USSR the benefit of the doubt. When he had first visited the Soviet Union in 1931, he was struck by the overriding sense of purpose there and found the country 'grim but great'. As time went on, Bernal discovered things that must have disturbed him deeply, particularly things relating to the fate of scientific colleagues in the Soviet Union. He interceded in response to the arrests of physicists, but in the atmosphere of the cold war, he did not criticise the USSR in public.

Lysenko is so often incanted, so little understood, so often cited against Bernal. There is nevertheless a vast literature on Lysenko and lysenkoism [20] situating it in its scientific and socio-historical context and analysing its complexities. I have contributed to it myself and I cannot do justice to its complexity here, but I want to assert that it is not enough to say that Lysenko was a charlatan, who did bad science, and Bernal should have said so. There was a real debate about the relative influence of heredity versus environment. There were the pressing needs of soviet agriculture. There was real searching about what science should be under socialism. I understand his ambivalence, although I do believe that he could have brought his considerable intelligence to bear upon it in a clearer and better way than he did and he could have brought his not inconsiderable influence to bear to shorten its span.

However, when it came to lysenkoism and stalinism, Bernal understood the many complexities and gave the benefit of whatever doubt he must have had to those he considered to be on the same side in an embattled world. That said, I still wonder. I especially wonder what he thought about the Moscow trials and the fate of Bukharin, who was such a crucial influence on him. [21]

As did Bukharin, Bernal looked at science under capitalism and under socialism with great knowledge and breadth of vision. He believed that the frustration of science was an inescapable feature of the capitalist mode of production and that science could only achieve its full potential under a socialist social order. He saw science as breaking the bounds of capitalism, which could not had contain a relentless search for truth and therefore generated a distrust of science.

Aspects of this argument seem outdated now, while other aspects are as relevant as ever. Certainly he underestimated the how far the formidable system that is capitalism would come to incorporate science. It is no longer marginal or underfunded in the world we inhabit today. It is spectacularly otherwise. The linking of science with industry that he so strongly advocated has come to pass, but not in a way that he foresaw or would approve.

Gary Werskey, in a recent paper with many mentions of Bernal, written for the recent workshop at Princeton [22], quoted Pettijohn as saying that "Bernalism has triumphed with capitalism" [23]

and Ravetz as considering Bernal to be a tragic figure in the history of science [24]. Werskey traced the incorporation of aspects of bernalism in a technocratic direction. He also highlighted the increasingly evident problems with the bernalist image of science as an inherently progressive force.

These problems are intensifying in the current climate, I believe. Looked at in a certain light, science is flourishing under capitalism, but examined more closely, it is also being constricted and even corrupted. The commercialisation of science, as part of the overall commodification of knowledge, with the endorsement and inducement of the state, is overtaking science today, not least here in Ireland. Scientific research is increasingly being shaped by market norms, even when it is funded by the public sector. This is profoundly problematic. Many scientists, as far as I can see, are either letting this momentum roll over them or even enthusiastically jumping aboard. One Irish physicist involved in university administration recently recommended commercialisation of research on the basis that it offered fun, fame and fortune. The inducements are many. Nevertheless, there is some disquiet, even if there seems to be little critique or resistance. At the very least, the problems arising should be discussed and debated.

We need contemporary scientists to take up the legacy of Bernal and his progressive contemporaries in examining the epistemological, ethical, social, political, cultural, economic dimensions of science and in challenging the prevailing orthodoxies and structures of power where necessary.

Bernal, known for his intellectual generosity and for his moral-political commitment to the communality of knowledge, stood for a fundamentally different ethos of science than that of many scientists today obsessed with their patents, promotions, prizes and pay (pushing for pay right off the public sector salary scales). Remarking on the many changes wrought by the British research assessment exercise and the rising culture of intellectual property, confidentiality agreements, licences and litigation, Alan Mackay has observed: “The happy tea-time professional gossip of scientists has disappeared with fears that their patents may be compromised.” [25]

While scientists are making their careers, many of them more and more distanced from philosophical reflection or social commitment, many in the humanities are becoming increasingly alienated and even hostile to science and scientists, partly because of a struggle for status and funding in academic institutions, but also because of a mutual intellectual incomprehension. The gap between the two cultures, so alien to Bernal, often seems to be widening. I am glad to see such initiatives as the projected Bernal Institute based at University of Limerick and a new Centre for Science in Society based at Dublin City University coming into the breach.

There is also increasing alienation and hostility to science in the wider society. There is distrust of the alliance of science and capital and a feeling of betrayal of the world’s needs, as genes are patented and designer drugs for the syndromes of the rich take precedence over the diseases of the poor. Scientists need to address such apprehensions, both in scrutinising their own practice and in explaining themselves to the public.

There is also much misinterpretation of science, new-age mystification of science and an irrationalist backlash against science in the wider culture and sometimes even in universities. Scientists should argue back against these tendencies instead of being oblivious of them. Bernal entered into polemics against such currents in his own time, as did his contemporaries, especially when scientists themselves were bringing irrationality into science, and their arguments against Jeans and Eddington are relevant today to *The Tao of Physics* [26] and *What the bleep do we know?* [27] and the many manifestations of nonsense where sense should be.

I often thought of Bernal during the science wars of the 1990s.[28] I believed that the integral thinking that he and his contemporaries brought to bear on their times needed to be brought to bear on ours. I agreed with those who wanted to defend the cognitive capacity of science against epistemological irrationalism, mysticism, conventionalism, especially against anything goes postmodernism. I also agreed with those who insisted on a strong socio-historical account of science against a reassertion of scientism. A better grounding in what the marxist tradition has brought to bear on these issues would have illuminated the terrain.

Marxism has made the strongest claims of any intellectual tradition before or since about the socio-historical character of science, yet never doubted its cognitive achievements. The 1930s left believed that the left should take its stand with science. The 1960s left, my generation, was more suspicious of science, although I left a greater affinity with the old left than did many of my contemporaries of the new left. The younger generation of today is more suspicious still.

In the tradition of Bernal, the left took its stand with science. I do not believe that the debunking of science in terms of its cognitive capacity or its social potential is an appropriate activity for the left. It is neither epistemologically sound nor politically progressive. The left should take its stand with science, a critically reconstructed, socially responsible science, but with all the higher possibilities of science. It should engage in a radical critique of the incorporation of science to global capital. It should open a path to the progressive potentialities of science.

Science and science studies are thriving today in many ways, but they are lacking in philosophical vision and social commitment. There is much funding, many metrics, all sorts of empirical studies. However, many studies are narrow and shallow and driven by market demand and fast-track careerism rather than search for truth and public interest. Even many social studies of science, including some associated with the strong programme [23], are too weak in conceptualisation and too random in contextualisation.

Science studies have become too small, too introverted. It exponents esoterically cite themselves and each other and fail to look wider. I picked up a science studies reader [30] recently and could not imagine why anyone would want to read it. It seemed obsessed with mini-debates of micro-tendencies. There was only weak evidence of relevant intellectual history and thin social context. There are no references to Bernal, Haldane, Caudwell, Bukharin, Hessen, Levins, Lewontin, Wartofsky, Hörz and only trivial ones to Marx and Engels.

Nevertheless, marxism has been a formative force in science studies, particularly through the work of Bernal, and it is a continuing influence, but it is not often acknowledged. It is sometimes "the philosophy that dare not speak its name." [31] Since the rise of the new right in the west and the collapse of socialist experiments in the east, marxism has become heresy again. Moreover, many of its premises have come to be so accepted that it seems no longer necessary or opportune to say from where they have come. It is not only dare not or need not, but know not. Many younger academics have only a weak knowledge of the history of their disciplines or the history of much else. They do not know that many of their premises come from marxism. There are a number of books in science studies today do not even mention Bernal or Haldane or Bukharin or Hessen, but assume premises for which they argued, although it is sometimes in a confused or enfeebled form.

Marxism lives on, but in circuitous and complex ways, sometimes in strong, brilliant, defiant ways, but sometimes too in weak, confused and debased ways. It is often marxism lite as an element of intellectual history lite to be raided for random insights for theory lite. Sociology of knowledge must be brought to bear upon trends in sociology of knowledge, including sociology of knowledge lite.

However, the overriding point for me is that marxism still makes more sense of science and all else than anything else I see around me. It has come down in the world, but it is still there and still needed.

So where have all the marxists gone? Some of us are still of us are there, struggling on, sadder but wiser. I only wish there were as many as David Horowitz seems to think.[32] Others are still there, but quieter. It does not come screaming off their cvs or web profiles as it does on mine, but it informs their work in many ways. Others are quasi-marxists or post-marxists. They have become discouraged by defeat or decentred by postmodernism. It was one thing when the wind was at their back, but they have been swept off their feet by crosswinds they could not withstand. Then there are the ex-marxists. Some of them go witch-hunting and draw up lists. Horowitz and other neo-conservatives are doing their best to stir up fear and resentment and to clear out whatever marxists and fellow travellers are left in US universities.

Universities are being harnessed to operate by market norms and survival of the fittest in commercial competition is outstripping all other forms of validation, particularly truth criteria, theoretical depth and breadth, moral responsibility, political engagement. There are powerful pressures disincentivising, eroding, marginalising critical thinking, creative thinking, systemic thinking, especially systemic thinking. There has never been such a totalising systematising force as contemporary global capitalism and yet never has there been such inhibition of totalising systemic thinking. This is a great paradox of our times.

The centralising market decentres the psyche. It organises consumption, but disorganises community. It can meet the demands of some for luxury homes, suvs and tivos, while it does not meet the most basic needs of others. Millions live in shacks made of rubbish without electricity or running water or basic health care. The market cannot meet the need for meaning or community for anyone. There is a seeking of truth, a striving for justice, that the system cannot fully repress. In this I place my hope in a revival of the kind of totalising thinking and collective acting that marxism has nurtured through the decades. Science is crucial to this.

The core of the legacy of Bernal, what is most relevant for our times, is the thrust to totalising and synthesising thinking. The qualities embodied by JD Bernal are precisely those missing in our universities and in our world today: synthesising vision and communal commitment. His enduring bequest is his vision of science as inextricably tied to philosophy and to politics. Such integrality is lacking in many contemporary debates on science and its relationship to philosophical assumptions and social structures.

It is important that the real and controversial contribution of Bernal be assessed by scientists today. Even today, he has much more to offer than a sense of Irish pride in a local lad who strode the world stage. The point is what he said and did while striding there and what we might learn from it even today.

So, in conclusion, it is not despite the fact that he was "as red as the flames of hell" [33], but because of it, that I think that we should honour him today.

Notes:

[1] Brown A 2005 *J D Bernal: The Sage of Science* (Oxford University Press)
[2] Bukharin N et al 1931, 1971 *Science at the Crossroads* (Frank Cass & Co)
[3] Goldsmith M 1980 *Sage: A Life of JD Bernal* (Hutchinson)
Swann B and Aprahamian F (ed) 1999 *JD Bernal: A Life in Science and Politics* (Verso)
Werskey PG 1978 *Visible College* (Allen Lane)
[4] Brown 2005 p114
[5] Coker C 2006 Solly Zuckerman and JD Bernal *Times Literary Supplement* 8 February 2006
[6] Holmes K 2006 The life of a sage *Nature* 440, 149-150 9 March 2006
[7} Christopher Caudwell was a British marxist who died in the Spanish civil war.
His books, including *The Crisis in Physics* 1939, were published posthumously.
[8] Rothstein A 1939 Vindicating Marxism *Modern Quarterly* 3, 1939 p290
[9] Sheehan H 1985, 1993 *Marxism and the Philosophy of Science: A Critical History*
(Humanities Press)
[10] Bernal JD 1937 Dialectical Materialism and Modern Science *Science and Society* vol2 no1Winter 1937
1935 *Engels and Science* (Labour Monthly series no8)
1934 *Aspects of Dialectical Materialism* (Watts & Co)
1949 *The Freedom of Necessity* (Routledge)
1952 *Marx and Science* (Marxism Today series no9)
[12] Bernal JD 1939 *The Social Function of Science* (Routledge)
[13] Bernal JD 1954, 1957, 1969 *Science in History* (4 volumes) (Penguin)
[14] de Charadevian S 2006 *Science* vol 312, no 5775 May 2006
[15] Bernal M 1987 *Black Athena* (Rutgers University Press)

[16] Mackay A 2003 J D Bernal (1901–1971) in perspective *J Biosci* vol 28, no 5, September 2003
[17] Graham L 1998 *What Have We Learned About Science and Technology from the Russian Experience?* (Stanford University Press) p14
[18] ibid p 1-31
[19] Richard Pipes and Robert Conquest are authors of many books about the USSR from a relentlessly hostile point of view.
[20] Graham L 1993 *Science in Russia and the Soviet Union* (Cambridge University Press)
Joravsky D 1970 *The Lysenko Affair* (University of Chicago Press)
Lecourt D 1977 *Proletarian Science?: The Case of Lysenko* (Humanities Press)
Medvedev Z 1969 *The Rise and Fall of TD Lysenko*
Sheehan H 1993 *Marxism and the Philosophy of Science: A Critical History*
Lewontin R and Levins R 1976 The Problem of Lysenkoism *The Radicalisation of Science* (ed Rose and Rose)
Young R 1978 Getting Started on Lysenkoism *Radical Science Journal* 6/7
[21] Bukharin was a particularly strong influence on Bernal. Nikolai Ivanovich Bukharin (188-1938) was the youngest, most intellectual, most sensitive, most sparkling of the original bolshevik leaders. He was a leading theoretian and politician of the USSR. He is the personification of a path not taken. He was a member of the politbureau and central committee of the Communist Party of the Soviet Union, editor of *Pravda*, head of the Communist International. In the struggle for power that took place in the late 1920s, he was a potential successor to Lenin, but was overtaken by Stalin. He was first sidelined and then arrested, tried and executed. It came to light during the Gorbachev period that Bukharin wrote four book length manuscripts while in prison. One dealing with philosophy and science was published in English in 2005 as *Philosophical Arabesques*. See introduction Sheehan H 2005 “A voice from the dead” (Monthly Review Press).
[22] Werskey G 2006 The Radical Critique of Capitalist Science: A History in Three Movements draft background paper for Princeton University workshop on Geopolitics, Marxism and 75 Years of Science Studies 31 March 2006
[23] Petijohn P 1998 Needham, Anglo-French Civilities and Ecumenical Science *Situating the History of Science* (ed Habib S and Dhruv R) (New Delhi: Oxford University Press) p195, cited by Werskey, ibid p30
[24] Ravetz JR 1990 The Marxist Vision of JD Bernal The *Merger of Truth with Science: Essays in Critical Science* (Cassell) p165, cited by Werskey, op cit
[25] Mackay, op cit
[26] Capra F 1975, 2000 *The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism* (Shambhala)
[27] Arntz W and Chasse B 2004 *What the bleep do we know?* (Sacred Science) film and dvd
[28] Gross P and Levitt N 1994 *Higher Superstition* (Johns Hopkins University Press)
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Sokal A and Bricmont J 1999 *Intellectual Impostures: Postmodern philosophers' abuse of science* (Profile)
Sheehan H 2001 The drama of the science wars: what is the plot?
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[29] The strong programme in the sociology of knowledge is associated with science studies at University of Edinburgh, in particular with the work of Barry Barnes, David Bloor and Donald MacKenzie
[30] Biagioli M (ed) 1999 *The Science Studies Reader* (Routledge)
[31] Colin Sparks used this phrase referring to marxism in the context of cultural studies at a conference of International Association for Mass Comminication Research in Dublin in 1993.
[32] Horowitz D 2006 *The Professors: The 101 Most Dangerous Academics in America* (Regnery)
[33] In 1939 when John Anderson, minister for civilian defence, was questioned about his recruitment of Bernal as a free ranging consultant, he replied: "Even if he is as red as the flames of hell, I want him." cited by Brown, op cit, p135

Marx Engels Forum in Berlin 2006 (photo by H Sheehan)

Plaque in honour of JD Bernal Nenagh, Co Tipperary 2006 (photo HS)

Speakers at Bernal event in Limerick 1 June 2006 (photo D Fahy)