

CHAPTER ONE

THE VIENNESE BACKGROUND

Ernst Mach was born in Chirlitz, Moravia, in 1838 into a cultured, freethinking family. Practically for all of the scientist's long life, Austria-Hungary was ruled by Emperor Franz-Joseph, who reigned from 1848 to 1916. Mach's father, Johann, was an eccentric who had studied science and philosophy in Prague and who was, for a time, a private tutor to the sons of the Baron Brethon in Vienna. He preferred farming and his own schemes, including the surprisingly half-successful idea to raise silkworms in Austria.¹ Mach owed his first education in science to his father's garden-physics demonstrations.

The Mach family was sympathetic to the calls for reform and self-determination that followed the Revolution of 1848. They even harbored a fugitive professor who had supported the Hungarian uprising.² The new regime of eighteen-year-old Franz-Joseph cracked down hard on the Hungarian revolt and its friends and got off to an authoritarian start; Erwin Hiebert writes of the effect of these times on Mach's distrust of authority:

Parental sympathies in the family home were certainly on the side of the Hungarian revolution and critical of the autocracy of the Hapsburg monarchy. Accordingly Mach was brought up in an environment that nurtured skepticism and unrestrained critical and stubborn inquisitiveness about the natural world, politics, religion and the status quo in general.³

In a surprising turn, the latter half of the reign of the bewhiskered and medal-bedraped Franz-Joseph was marked by increasing liberalization, in which the different ethnic groups within the empire (Czech, Jew, Hungarian, Romanian, and Serbian) were knit together by a benignly incompetent bureaucratic empire, familiar from the novels of Kafka, in which dormant nationalisms emerged with rancor. Mach himself, as rector of the Prague university, was plunged into a conflict that divided the institution into Czech and German-speaking halves.⁴

Franz-Joseph's reign was also marked by a cultural enlightenment, tolerance of political criticism (from a spectrum that included Karl Kraus and Austro-Marxists such as Friedrich Adler), and a flourishing of art and science that is hard to overestimate. To some degree, the openness of the Austro-Hungarian Empire was due simply to its ineffective efforts to suppress opposition, as William Johnston remarks in his excellent book, the *Austrian Mind*:

Nothing illustrated so well the sloppiness of bureaucracy as the manner in which it handled censorship of the press. Each morning preliminary copies of every paper were rushed to the censor, who might order any story confiscated. In its place would appear an empty space, bearing the word *konfisziert*. Because papers were read so hastily, frequently a story confiscated in one paper would be overlooked in another. In such cases, every paper was allowed to reprint the story, citing the unconfiscated version as its source.⁵

Vienna, city of dreams, exhibited a manifest content of authority, rationality, and science coexisting with a latent reality of the anti-authoritarian, instinctual and peculiar, a juxtaposition that would reemerge in Mach's work, as it did in that of many of his famous contemporaries. Sigmund Freud, Ludwig Boltzmann, Franz Brentano, Robert Musil, Ludwig Wittgenstein, Gustav Klimt, and even James Joyce in Trieste were all at some point under the wing of this empire "Kakanien" of Musil's novel, *der Mann ohne Eigenschaften*. As Thomas Szasz writes in his introduction to the *Analysis of Sensations*:

Parallel to the political and social changes, an atmosphere developed which was very encouraging to the arts and sciences...The years between 1848 and the first world war in Austria-Hungary were characterized by a widespread belief in the stability and security of the government and the State coupled with a belief that forces promoting slow but steady changes toward ever better social conditions were constantly at work. This at least was the social Weltanschauung of the middle, upper and still higher classes of this society. Almost all of Mach's life (he died in 1916) was spent during this epoch which could be called the "Age of Security" (in Central Europe).

Among the postrevolutionary movements that affected Mach directly⁶ the most significant was the Exner-Bonitz educational reform of the 1850s. These two ministers of education were disciples of the philosopher and pedagogue J.F. Herbart (1776-1841), who proposed ending the rote learning of the cramschools, pitching education directly at the native critical and reasoning powers of the student, giving him time to absorb and fight his way through to new ideas. Given Mach's supreme critical powers and the strong influence of Herbart on Mach's thought, this influence is not without consequence.

The most important science in Vienna at mid-century was no doubt medicine. Not coincidentally, it was the site of the largest centralized hospital in Europe, which, as Wolfram Swoboda remarks,⁷ permitted physicians to observe the progress of diseases and to perform autopsies in large numbers of cases, since all the patients flowed through the same institution. The University of Vienna was geared toward the education of physicians and physiologists, which is evident from the high caliber of talent educated there, such as the young Freud and Breuer, to name two who worked with Mach's teacher Ernst Brücke. Mach's first job, in fact, was to teach a course of physics for medical students.

Swoboda has thoroughly researched the forces that led to a specific brand of Viennese empiricism and physicalism one generation *before* Mach. The Viennese doctors had rejected the vogue of *Naturphilosophie* from Germany and the various forms of vitalism that accompanied it. Vitalism was the idea that living organisms possess within a "vital force" (*Lebenskraft*) unexplainable by material means, while *Naturphilosophie* was a principle-driven amalgam of science and philosophy, loosely based on the theories of Schelling and Hegel, and a downright bane to medical research since its abstract "polarities" and "oppositions" sanctioned no specific treatments.⁸ The Viennese reaction was a race to the opposite pole of extreme empiricism on the model of English philosophy, as Hugo Dingler describes:

Mach's first beginnings were made during the time when the struggle against the groundless speculations of the Schelling- and Hegelian school still echoed faintly in the distance. In reaction against that groundless over-stretching of a completely unproven principle, a most extreme Empiricist cast of mind, just as unfounded in the last analysis, had established itself, and was supported by the influence of English philosophy.⁹

As Swoboda relates, Mach's two most important teachers, Ernst Brücke and Carl Ludwig, were students of Johannes Müller, who had founded an institute in Berlin for the study of human physiology. Müller, the author of the famous *Handbuch der menschlichen Physiologie* (1838), was an intriguingly complex personality: a hard-headed physiologist and experimenter who remained a vitalist and a phenomenologist on the model of Goethe. As we will see later, Müller even proposed reviving Aristotle's theory of direct perception in connection with his famous specific-energies doctrine to replace Locke's representative causal theory. Ludwig and Brücke apparently retained some of the complexity of their teacher. Mach relates of Ludwig, for example, that he believed physiological processes were only the "outside" of sensational processes.¹⁰ Brücke was also the teacher of Freud and held a Herbartian doctrine of psychical "forces" and mental energies that is similar in Freud and Mach.¹¹

But there were other students of Müller, such as Hermann von Helmholtz and Emil DuBois-Reymond, who believed that even a good physiological account should be further reduced to the mechanical atomic theory. First materialism and then reductionism (in the formula "Physiology as applied physics") was the creed of these men. The view was very influential in the medical community, as Michael Heidelberger writes: "In the later fifties and in the sixties materialism enjoyed its greatest popularity and among doctors the materialistic *Weltanschauung*...was especially current."¹²

Dingler says that anti-metaphysics (so often associated with Mach himself) was actually the rallying cry of the generation *before* Mach in their crusade against *Naturphilosophie* and vitalism. According to Dingler, anti-metaphysics was an *idée fixe* for Helmholtz, who often used the word "metaphysics" in the crudest sense to mean anything unverifiable with the human sense organs. "With Mach," Dingler added, "the concept of metaphysics is no longer so purely superficial."¹³

Helmholtz had no compunctions about the conflict between *atomism* (believing that qualityless atoms are the ultimate constituents of matter)¹⁴ and *phenomenalism* (the position that sensations provide the immediate data of science against which theories are tested). He believed that sensory qualities and their elements, despite their importance in providing sensory evidence, were superficial for physics and could be explained by recourse to the purely quantitative behavior of large numbers of atoms, similar to the way that a *pointilliste* painting is a mixture of colored dots.¹⁵ The conflict seems to have disquieted Mach greatly. Although his early works echoed the standard view,¹⁶ the young Mach realized early, and with more penetration than the preceding generation, the ontological conflict between sensations (or their elements) and sensationless atoms. How could Helmholtz hold to the epistemological primacy of

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