Confirming Extant Life on Mars. G. V. Levin, Arizona State U., Beyond Center, College of Liberal Arts and Sciences, University Dr. and Mill Ave., Tempe, AZ 85287**, gilbert.levin@asu.edu**.

Introduction: The direct search for extraterrestrial life began in 1976 with the Viking Mission to Mars. The Labeled Release (LR) experiment obtained signals indicating extant microbial life. However, most scientists considered the reactions abiotic. Levin and Straat [1] describe the LR in the light of today's increased knowledge and find support for biology. Few scientists accept that conclusion [2], although many now view the LR results as ambiguous, re-opening the possibility of life. No life detection experiment has been sent to Mars in the 42 years since Viking. I propose to resolve this key scientific issue by re-sending the LR with added chiral capabilities to Mars.

Background for Life on Mars: Prior to Viking, little was known about the habitability of Mars. Since Viking, many landers, rovers, orbiters, and observers from Earth have probed Mars. On Earth, microorganisms have been found living in environments similar to some on Mars. Prospects for life on Mars have ranged from it being a dead planet without any liquid water to one with past habitability [3]. More recently, moderately complex organic molecules have been found in Martian surface materials; even kerogen, a biodegradation material, has been indicated [4]. On the other hand, no life-inimical factor, including radiation [5] has withstood scrutiny. Thus, the time has come to attempt to resolve this paramount scientific question of our time: is there life beyond Earth?

The Chiral LR is Definitive: The chiral LR builds on the great sensitivity of the LR (detecting as few as 20 cells) and its perfect test history (no false positives or false negatives in thousands of tests). The LR measures on-going metabolism, not a questionable biomarker. The experiment is augmented to detect chirality of any reaction. All known life forms, when directly metabolizing stereoisomeric molecules for energy, metabolize only the L- or D-form. Chemical reactions cannot distinguish between stereoisomers of any such molecule, reacting equally with both forms. Thus, a chiral response offers strong support for its biological nature.

Experimental Details: In keeping with scientific protocol, the Viking results would be tested by dosing Mars samples with the original Viking LR C^{14}-labeled mixture of substrates. Expanding the experiment, isomers of the chiral substrates (alanine and lactate) would be offered separately to separate samples. Additional radio-labeled chiral substrates would possibly include S^{35}, such as cysteine. If living organisms are present, the Viking LR results should be confirmed, and those substrates responsible identified. Responses from non-Viking substrates would increase knowledge about the Martian life. Sterilization or vital impairment of the soil by heat, anti-metabolites or adverse environmental conditions would provide "controls" [6] in addition to the chiral determination.

The Instrument, Avoiding Terrestrial Contamination; Results: The tests and controls would be performed by a battery of small projectile-type instruments already in an advanced state of concept [7]. Approximately 20-cm-long, each carries a single nutrient in a vial. An array of such instruments is mounted within a rotatable closed canister. To prevent contamination of the experiment with terrestrial microorganisms, the canister would be heat-sterilized pre-mission. The canister would then be fixed to the spacecraft or its rover. After the Mars landing, a canister brake would be released, allowing a vane on the canister to rotate it into the wind. The canister would be mounted at an angle to cause the projectiles, launched by their individual squibs, penetrating the thin cover, to land about 50 m upwind of the rover and/or spacecraft. That will prevent contamination of the experiment by any terrestrial microbes carried by the spacecraft. The air-foiled instrument lands head-first, forcing surface material up its hollow nose-tube and breaking the nutrient container, wetting that sample. (The nutrient had been heated above freezing within the thermally-insulated projectile prior to its launch). A beta detector in the projectile monitors any rising radioactive gas. The accumulating count data is sent to the spacecraft by a tiny FM radio in each projectile via its trailing antenna. The entire array of test and control data would be relayed to Earth for analysis.

References: [1] Levin, G.V. and Straat, P.A. (2016) *Astrobiology*, **16**, 10, 798-810**, [2**] Levin, G.V. (2014) *Astrobiology*, **14**, 12, 101-103, [3] Eigenbrode, J.L. *et al.* (2018) *Science*, **360**, 1096-1101, [4] *Ibid*, [5] Mancinelli, R.L. (2015) *Int. J. Astrobiology*, **14(1),** 123-128, [6] Levin, G.V. *et al*. (2010) *J. Cosmology*, 920-929. [7] Levin, G.V. (2013) Proc. Instruments, Methods and Missions for Astrobiology XVI, 8865-2.