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Benjamin D. Sokolowsky* (bds021@bucknell.edu), 701 Moore Ave c1737, Lewisburg, PA 17837, **Amy G. VanHooft** (agvanhooft@rochester.rr.com), 482 West Ave, Brockport, NY 14420, **Rachel M. Volkert** (volkertr@uni.edu), 315 North Guilford Street, Sumner, IA 50674, and **Clifford A. Reiter** (reiterc@lafayette.edu), Department of Mathematics, Lafayette College, Easton, PA 18042. *An Infinite Family of Perfect Parallelepipeds.*

A perfect parallelepiped has edges, face diagonals, and body diagonals all of integer length. We prove the existence of an infinite family of dissimilar perfect parallelepipeds with two nonparallel rectangular faces. We also show that we can obtain perfect parallelepipeds of this form with the angle of the non-rectangular face arbitrarily close to 90° . Finally, we discuss the implications which this family has on the famous open problem concerning the existence of a perfect cuboid. This leads to two conjectures that would imply no perfect cuboid exists. (Received September 09, 2012)