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ON THE GAUSS-BONNET FORMULA  
FOR LOCALLY SYMMETRIC SPACES OF NONCOMPACT TYPE

by Enrico LEUZINGER

ABSTRACT. Let  $X$  be a Riemannian symmetric space of noncompact type and rank  $\geq 2$  and let  $\Gamma$  be a non-uniform, irreducible lattice in the group of isometries of  $X$ . A Gauss-Bonnet formula for the locally symmetric quotient  $V = \Gamma \backslash X$  was first proved by G. Harder. We present a new simple proof which is based on an exhaustion of  $V$  by Riemannian polyhedra with uniformly bounded second fundamental forms.

INTRODUCTION

The generalized Gauss-Bonnet theorem of C.B. Allendoerfer, A. Weil and S.S. Chern asserts that the Euler characteristic of a *closed* Riemannian manifold  $(M, g)$  is given by

$$\chi(M) = \int_M \omega_g$$

where the Gauss-Bonnet-Chern form  $\omega_g = \Psi_g dv_g$  is (locally) computable from the metric  $g$  (see [AW], [C]).

In several articles J. Cheeger and M. Gromov investigated the Gauss-Bonnet theorem for *open* complete Riemannian manifolds with bounded sectional curvature and finite volume. They in particular showed that such manifolds  $M^n$  admit an exhaustion by compact manifolds with smooth boundary,  $M_i^n$ , such that  $\text{Vol}(\partial M_i^n) \rightarrow 0$  ( $i \rightarrow \infty$ ) and for which the second fundamental forms  $\text{II}(\partial M_i^n)$  are uniformly bounded (see [CG1], [CG2], [CG3] and also [G] 4.5.C). By a formula of Chern one has  $\chi(M_i^n) = \int_{M_i^n} \omega_g + \int_{\partial M_i^n} \eta_i$  where  $\eta_i$  is a certain form on the boundary  $\partial M_i^n$  (see [C]). The above two properties imply that  $\lim_{i \rightarrow \infty} \int_{\partial M_i^n} \eta_i = 0$  and hence  $\chi(M_i^n) = \int_{M^n} \omega_g$  for sufficiently large  $i$ . As a consequence the Gauss-Bonnet theorem holds whenever  $\chi(M_i^n) = \chi(M^n)$  for all sufficiently large  $i$ .