

Huybrechts, page 64 problem 2.1.4:

Let  $X$  be a simply connected compact complex manifold. Then any holomorphic map  $f: X \rightarrow T$ , where  $T \in \mathbb{C}^m/\Gamma$  is a compact complex torus, is constant.

step 1:

Proof: Let  $g: \mathbb{C}^m \rightarrow T$  be the universal cover (mapping  $z$  to  $z + \Gamma$ ). There exists a continuous lift  $\tilde{f}: X \rightarrow \mathbb{C}^m$ , such that  $g \circ \tilde{f} = f$ , since

$X$  is simply connected (the map lifting property of the universal cover).

$\tilde{f}$  is holomorphic!

Step 2:

The map  $g$  is holomorphic, by definition of the complex structure of  $T$ , and  $g$  is locally invertible, i.e., for each point  $P \in T$  there exists a connected open neigh  $U$  of  $P$ , such that for every connected component  $\tilde{U} \subset \mathbb{C}^m$  of  $g^{-1}(U)$ , the restriction  $g|_{\tilde{U}}: \tilde{U} \rightarrow U$  is an isomorphism. So if  $V$  is a connected component of  $f^{-1}(U)$ , then

$\tilde{f}|_V: V \rightarrow \mathbb{C}^m$  is the composition

of  $g|_{\tilde{U}} \circ \tilde{f}$ , where  $\tilde{U}$  is the connected component of  $g^{-1}(U)$  containing  $\tilde{f}(V)$ . Thus,  $\tilde{f}|_V$  is the composition of holomorphic maps, hence holomorphic. Thus,  $f$  is holomorphic everywhere.

Step 3: Write  $\tilde{f} := (\tilde{f}_1, \dots, \tilde{f}_m)$ , where  $\tilde{f}_i: X \rightarrow \mathbb{C}$  is holomorphic. Then  $\tilde{f}_i$  is a constant function, since  $X$  is compact. Hence  $\tilde{f}$  is a constant function. Thus  $f := g \circ \tilde{f}$  is a constant function.  $\square$