ABSTRACT

In these lecture notes,we firstly introduce substantial and particular notions on free reslutions, semi-free resolutions and projective resolutions. From these notions, more precisely from the notion of semi-free resolution, we then adress the Eilenberg Moore differential Tor and provide relative useful properties and fundamental results. Beside numerous applications of the above mentioned Eilenberg Moore differential Tor, we recall successively that for a given topological space X*, the associated normalized singular cochain,* $N^*(X)$*, is endowed with the strongly homotopy commutative (shc) algebra structure. Furthetmore this strongly homotopy commutative algebra structure induces on the Hochschild homology of the normalized singular cochain* $N^*(X)$ *with coefficients in itself,* $HH^*(N^*X; N^*X)$*, an algebra structure. Afterwards we establish that the vector space isomorphisms below*

$$HH_*(N^*X; N^*X) \cong Tor^{(N^*X)^e}(N^*X, N^*X),$$

$$H^*(LX, \mathbb{K}) \cong Tor^{N^*(X\times X)}(N^*X, N^*X),$$

where LX *denotes the space of free loop space of* X*, are indeed graded algebras isomorphisms. Finally after having established that the normalized singular cochain algebra,* $N^*(X)$*, of a given topological space,* X*, and its opposite algebra,* $(N^*X)^{opp}$*, are isomorphic as algebras, we show that the differential graded vector space homorphism* $N^*X \xrightarrow{Id} N^*X$ *is a left(respectively right)* $(N^*X \otimes N^*X - N^*(X\times X))-$ *modules homomorphism. We obtain therefore the following sequence of graded algebras isomorphisms:*

$$Tor^{N^*(X\times X)}(N^*X, N^*X) \cong_{alg} Tor^{N^*X\otimes N^*X}(N^*X, N^*X) \cong_{alg} Tor^{(N^*X)^e}(N^*X, N^*X),$$

from which flows not only the correct version of the proof of the initial form of Jones isomorphism but also and above all the proof of the fact that this isomorphism is a graded algebras isomorphism.