

# EMBEDDINGS OF SURFACES IN $E^3$

C. E. BURGESS<sup>1</sup> AND J. W. CANNON<sup>2</sup>

## CONTENTS

	Page
1. INTRODUCTION .....	260
2. DEFINITIONS .....	263
2.1. Euclidean spaces .....	264
2.2. Manifolds-with-boundary .....	264
2.3. Piecewise linear (PL) structures .....	265
2.4. Tame sets, wild sets, 2-spheres, crumpled cubes, and collared sets ..	266
2.5. Decomposition spaces and cellular sets .....	267
3. EXAMPLES OF WILD SPHERES .....	267
3.1. The Alexander horned sphere .....	267
3.2. The Antoine sphere .....	268
3.3. The Fox-Artin sphere .....	270
3.4. The Bing sphere .....	271
3.5. Other wild spheres .....	272
3.6. Disjoint spheres and disks in $E^3$ .....	273
4. BASIC THEOREMS .....	274
4.1. Separation and accessibility .....	274
4.2. Tietze extension theorem .....	275
4.3. Spaces of functions .....	276
4.4. Polyhedral spheres in $E^3$ .....	277
4.5. Dehn's lemma and related theorems .....	279
4.6. Polyhedral approximations of spheres .....	281
4.7. Linking .....	285
4.8. Brief outline of plane topology .....	286
5. GENERAL PROPERTIES OF SPHERES AND CRUMPLED CUBES IN $E^3$ .....	290
5.1. Tame arcs and other tame continua on spheres .....	290
5.2. Piercing spheres with arcs .....	292
5.3. Neighborhoods of spheres .....	295
5.4. Small disks on surfaces in $E^3$ are on small spheres .....	296
5.5. Improving intersections of spheres with lines and with other spheres .....	297
5.6. Equivalence of complements of crumpled cubes and arcs in $E^3$ ..	297
5.7. Pushing a 2-sphere into its complement .....	298
6. CHARACTERIZATIONS OF TAME SPHERES .....	300
6.1. Locally tame spheres .....	300
6.2. Spheres which can be homeomorphically approximated in their complementary domains .....	300
6.3. Free 2-spheres in $E^3$ .....	302

Received by the editors March 9, 1970.

AMS 1970 *subject classifications*. Primary 55A30, 55A35, 57A05, 57A10, 57A35, 57A40, 57A45, 57A50.

<sup>1</sup>Support from the National Science Foundation under GP-12025.

<sup>2</sup>National Science Foundation Postdoctoral Fellow.

Copyright © Rocky Mountain Mathematics Consortium