

Game Theory and Nuclear Weapons



Game Theory and Nuclear Warfare

- Cuban Missile Crisis
- Theory of Mutually Assured Destruction (MAD)
- Does this theory explain what happened during the Cuban Missile Crisis
- MAD and ABM
- MAD and nuclear proliferation to Rogue States and Terrorists

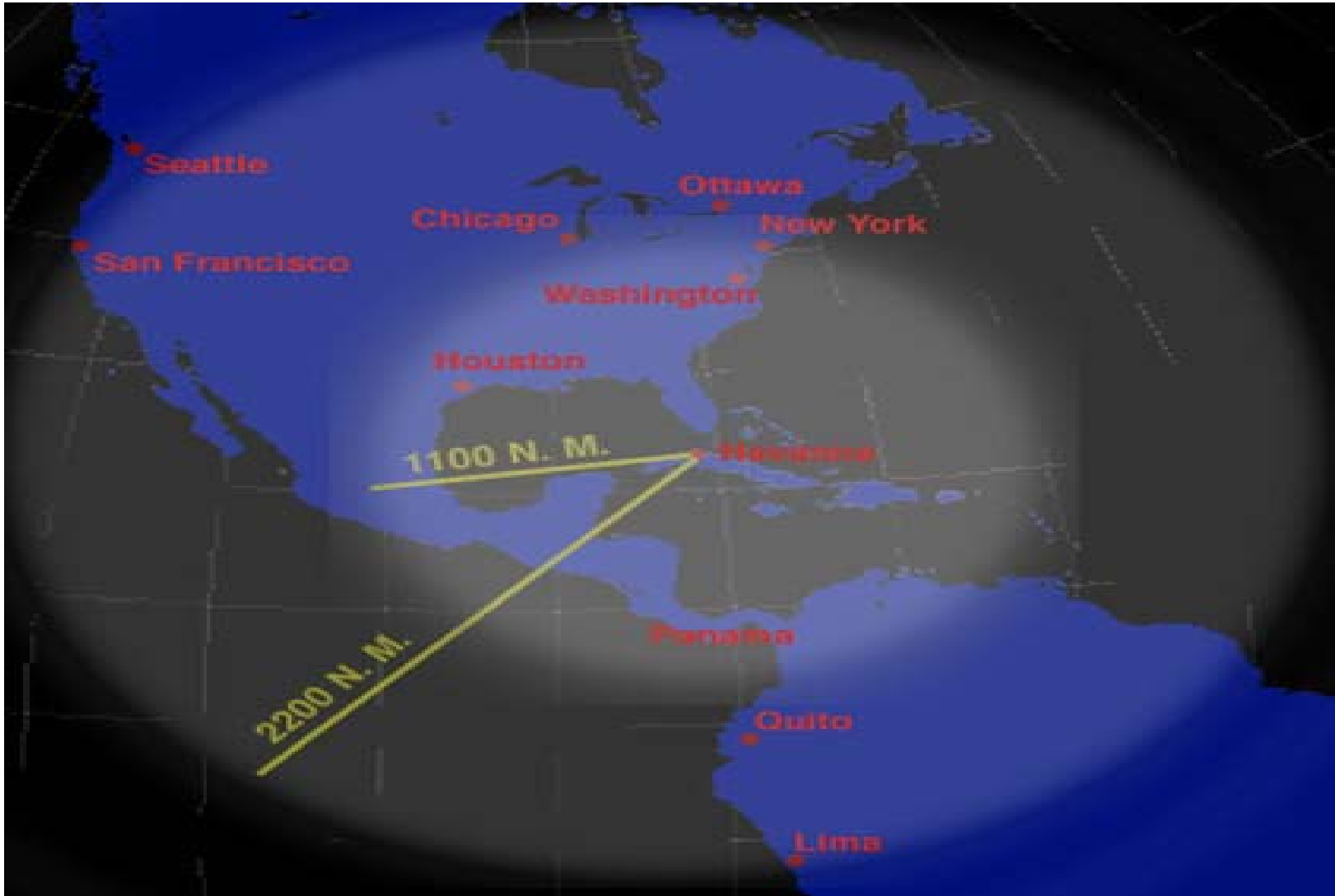
History of Cuban Missile Crisis

- October 1962 Soviet Union built Missile launchers in Cuba
- U.S. feared Soviet Union would be able to strike the U.S. with very little warning due to close proximity
- Kennedy placed naval Blockade of Cuba

Map of U.S. and Cuba



Map



Kennedy's Speech



Kennedy's Speech

- My fellow citizens: let no one doubt that this is a difficult and dangerous effort on which we have set out. No one can foresee precisely what course it will take or what costs or casualties will be incurred. Many months of sacrifice and self-discipline lie ahead—months in which both our patience and our strength will be tested—months in which many threats and denunciations will keep us aware of our dangers. But the greatest danger of all would be to do nothing.
- The path we have chosen for the present is full of hazards, as all paths are—but it is the one most consistent with our character and courage as a nation and our commitments around the world. The cost of freedom is always high—but Americans have always paid it. And one path we shall never choose, and that is the path of surrender or submission.
- Our goal is not the victory of might, but the vindication of right—not peace at the expense of freedom, but both peace and freedom, here in this hemisphere, and, we hope, around the world. God willing, that goal will be achieved.

Kennedy's Speech

- **First:** To halt this offensive buildup, a strict quarantine on all offensive military equipment under shipment to Cuba is being initiated.
- **Third:** It shall be the policy of this Nation to regard any nuclear missile launched from Cuba against any nation in the Western Hemisphere as an attack by the Soviet Union on the United States, requiring a full retaliatory response upon the Soviet Union.
- **Seventh and finally:** I call upon Chairman Khrushchev to halt and eliminate this clandestine, reckless, and provocative threat to world peace and to stable relations between our two nations.

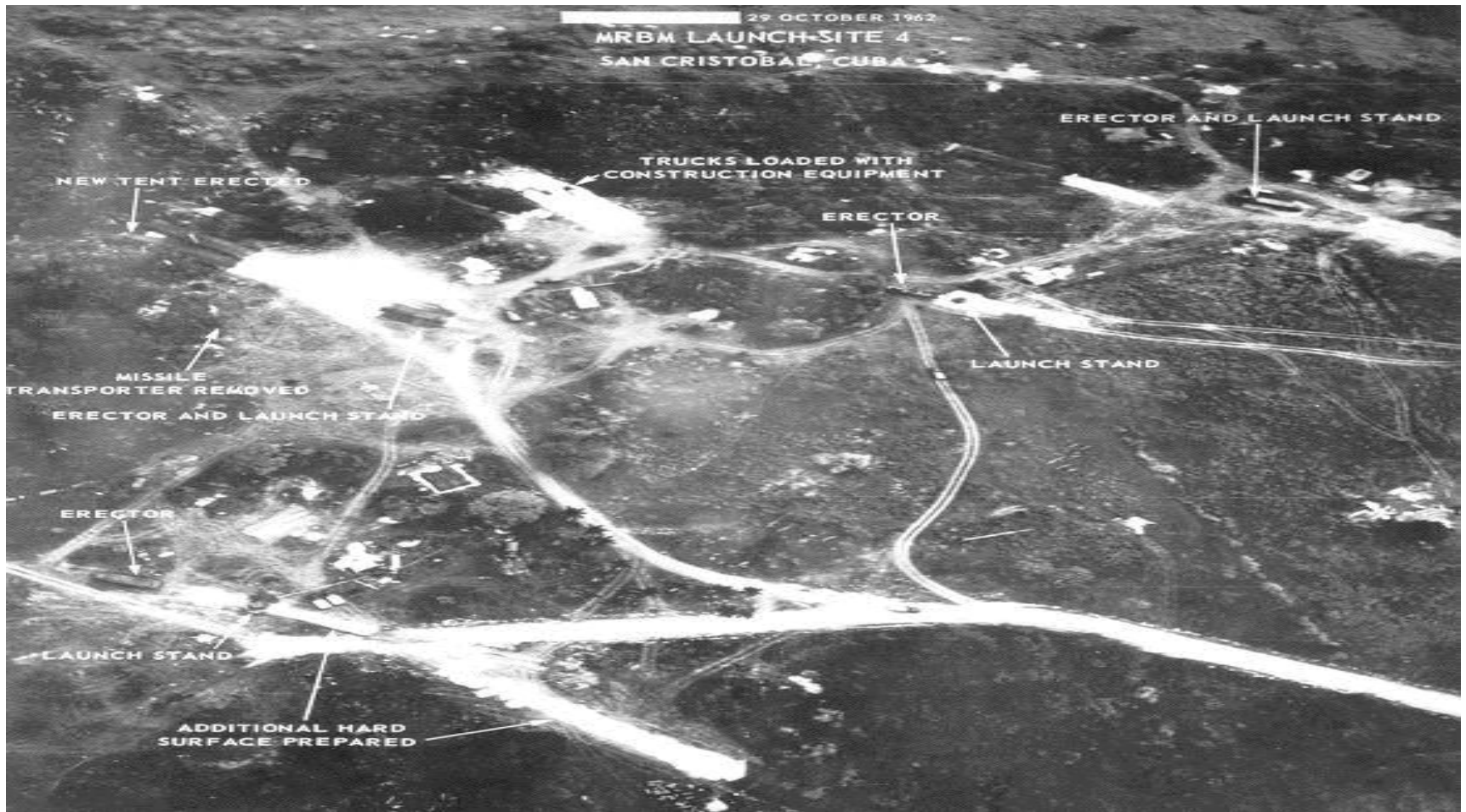
Pictures of Rocket Launchers



Pictures of Rocket Launchers



Pictures of Rocket Launchers



Pictures of Rocket Launchers



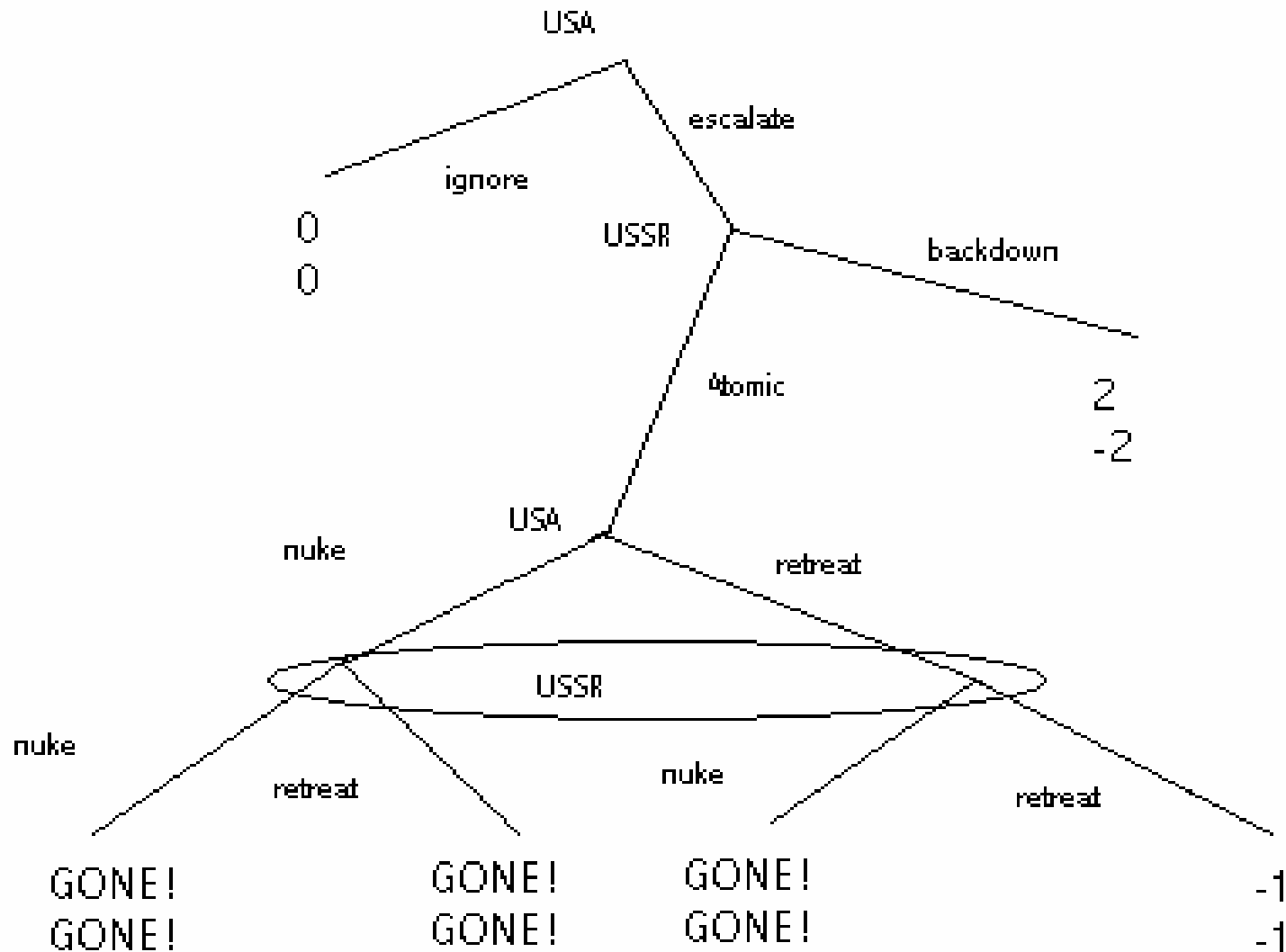
How was the conflict resolved

- The United States feared the worst
 - nuclear exchange - Armageddon
- 2 week naval blockade created much tension
- Soviet Union backed down and removed missiles
- The Cuban Missile Crisis was probably the most tense moment of the cold-war

Game Theory and MAD

- How can we rigorously explain what happened during the crisis?
- Game Theory offers solution
- Perhaps Nuclear weapons bring about Peace?
- Model.....

Game Theory: MAD



Atomic Subgame

USSR →		

USA ↓	Nuke	Retreat
Nuke	(<u>Gone!</u> , <u>Gone!</u>)	(Gone!, <u>Gone!</u>)
Retreat	(<u>Gone!</u> , Gone!)	(<u>-1</u> , <u>-1</u>)

Subgame Perfect Nash Equilibrium

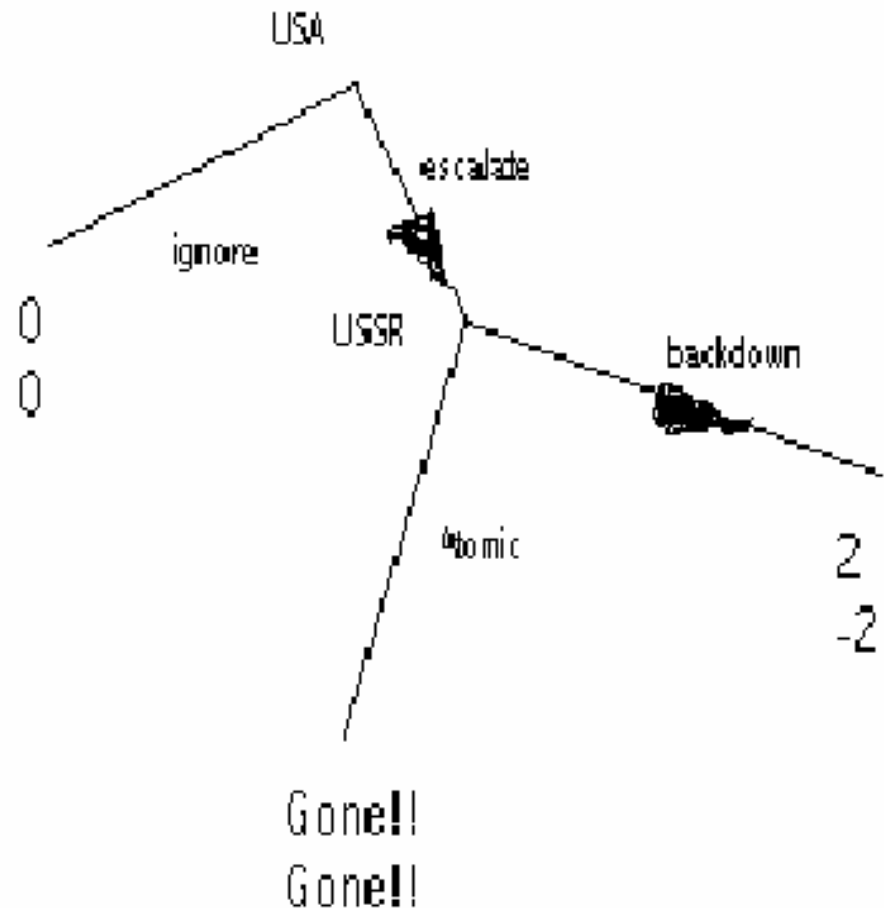
**Subgame Perfect
Nash Eqm**

US

→ EscalateNuke

USSR

→ BackdownNuke

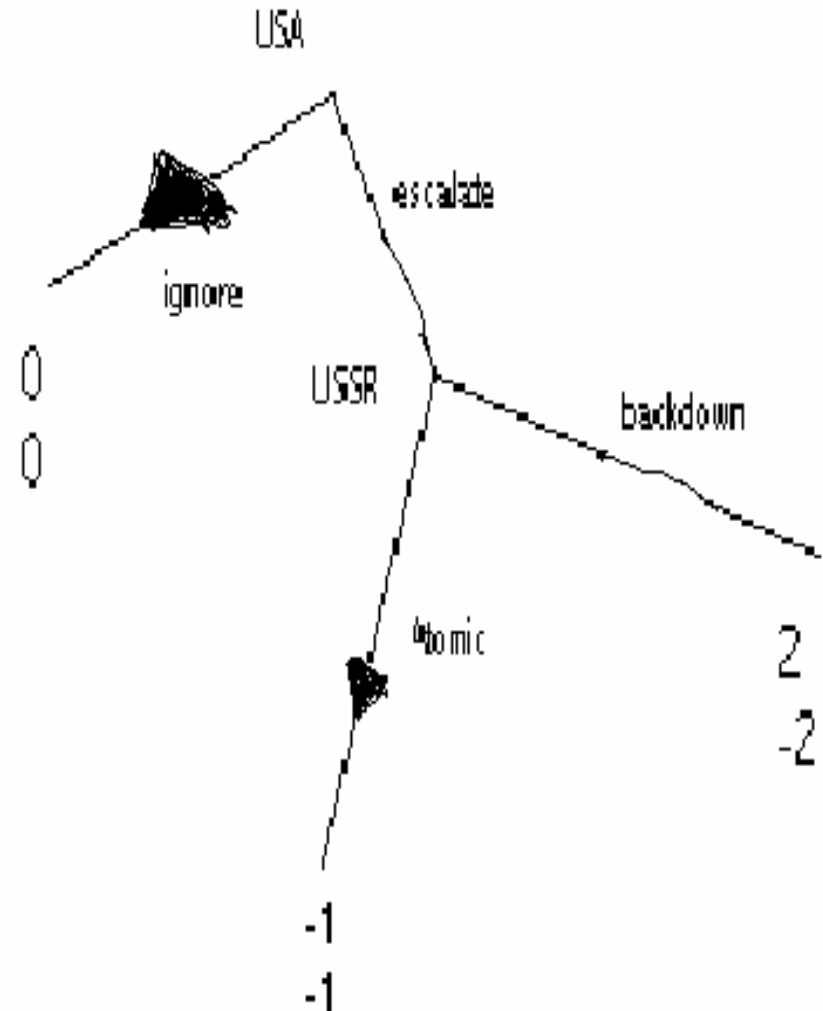


Subgame Perfect Nash Equilibrium

**Subgame Perfect
Nash Eqm**

USA
→ Ignore Retreat

USSR
→ Atomic Retreat



Is this what happened?

- **Khrushchev to Kennedy (USA-USSR choose nuke threat)**
October 24, 1962
- You, Mr. President, are not declaring a quarantine, but rather issuing an ultimatum, and you are threatening that if we do not obey your orders, you will then use force. Think about what you are saying! And you want to persuade me to agree to this! What does it mean to agree to these demands?

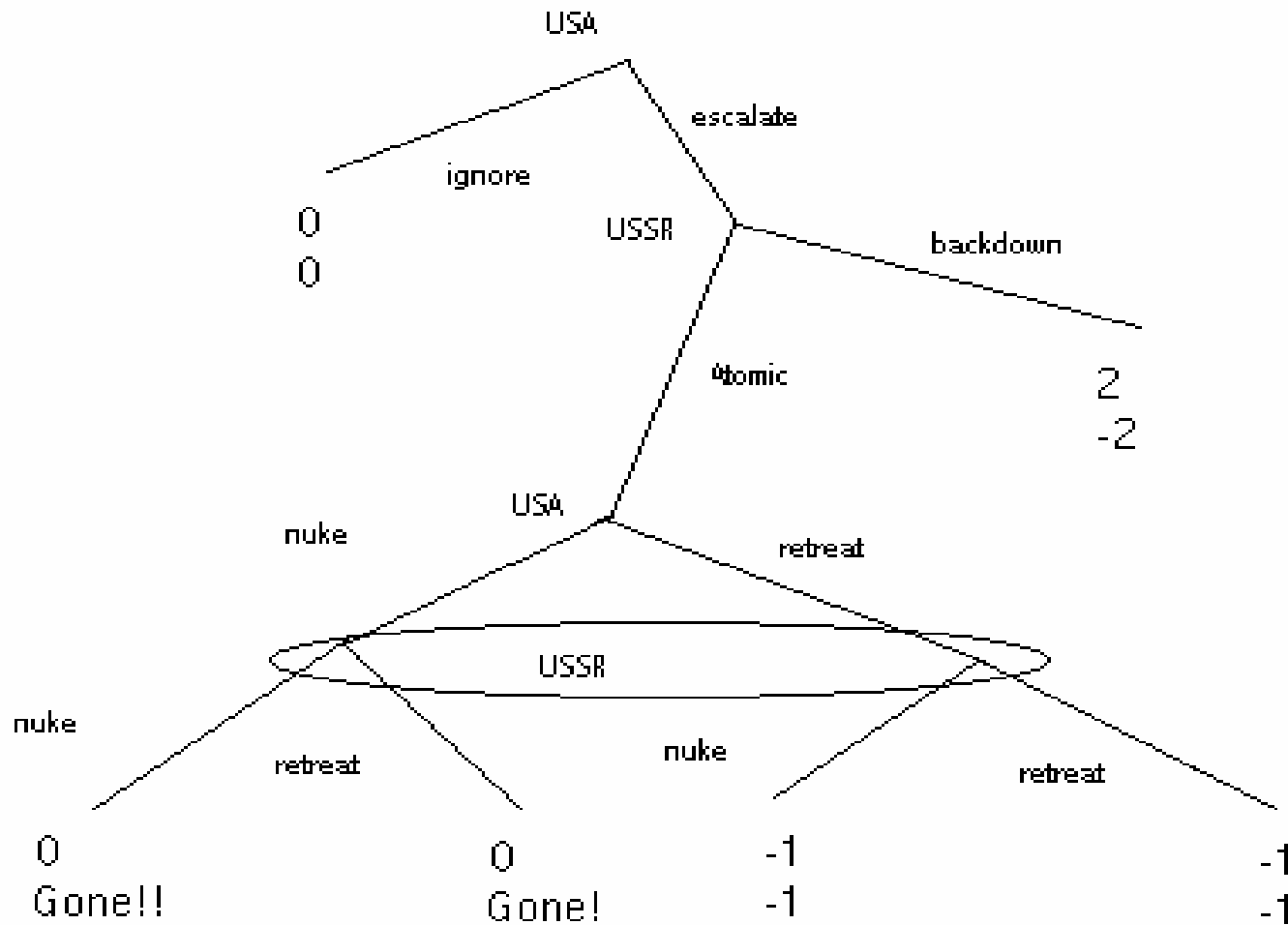
Is this what happened?

- **Kennedy to Khrushchev (USA plays Escalate)**
- **October 27, 1962**
- The first things that needs to be done, however, is for work to cease on offensive missile bases in Cuba and for all weapons systems in Cuba capable of offensive use to be rendered inoperable, under effective United Nations arrangements.

Is this what happened?

- **Khrushchev to Kennedy (USSR Backs down)**
- **October 28, 1962**
- the Soviet Government, in addition to earlier instructions on the discontinuation of further work on weapons constructions sites, has given a new order to dismantle the arms which you described as offensive, and to crate and return them to the Soviet Union.

ABM Game Tree



ABM Atomic Subgame

USSR →		

USA ↓	Nuke	Retreat
Nuke	(<u>0</u> , <u>Gone!</u>)	(<u>0</u> , <u>Gone!</u>)
Retreat	(-1, <u>-1</u>)	(-1, <u>-1</u>)

ABM SPNE

ABM SPNE

USA

→ EscalateNuke

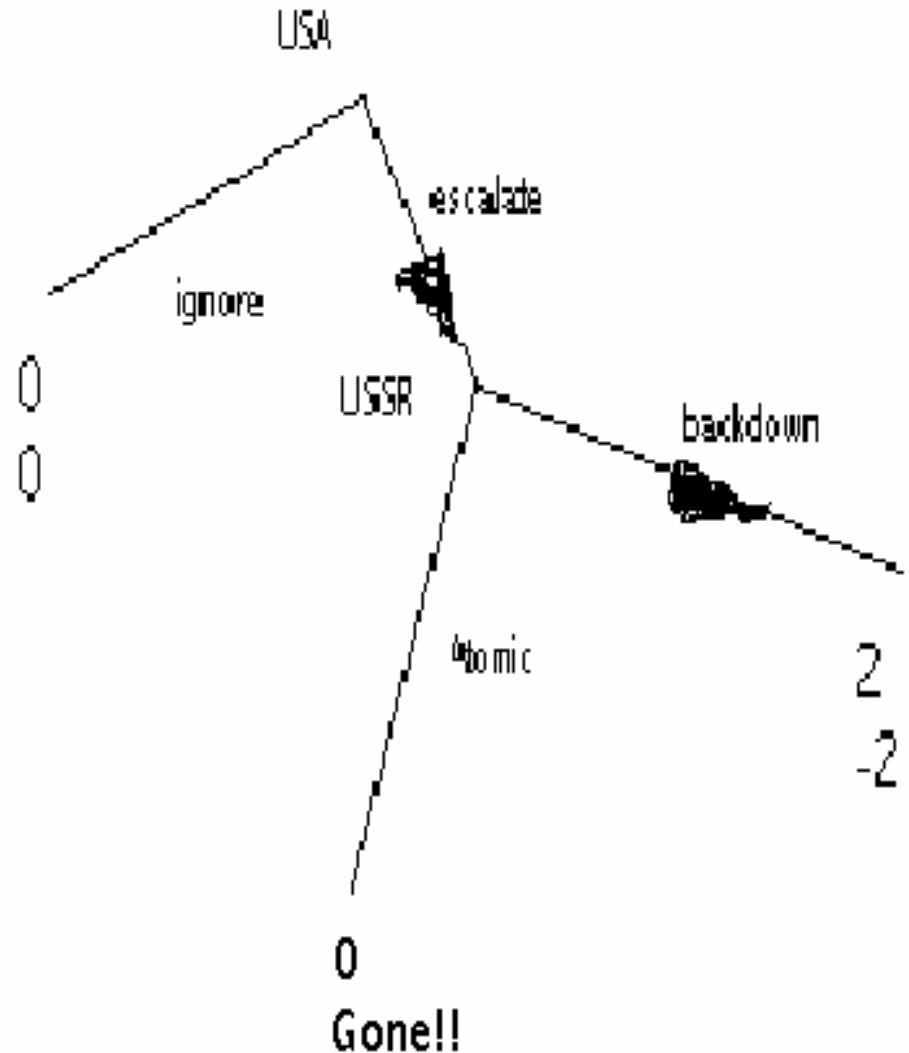
USSR

→ BackdownNuke(Retreat)

No longer have SPNE where

USA: IgnoreRetreat

USSR: AtomicRetreat



Pro's and Con's of ABM Treaty

- U.S. never has to worry about Nuclear assault (But they never did before!!)
- U.S. can always escalate and win conflicts
- If another country has ABM technology, the U.S. must backdown
- Discourages new nations from building Nukes since they are ineffective
- Think of non-game theory reasons?